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CONTENTS:

	PAGE
Foreign Plant and English Colonies	687
On Drehstrom Motors with Reduced Speeds (*illustrated*) ...	689
A "New" Force	690
Note on the Pressure of the Trolley Wheel Against the Wire (*illustrated*)	691
Electrolytic Copper and Silver Refining (*illustrated*)	692
The Achievements of Physical Chemistry	693
McDonald's Battery and its Tests (*continued*)	694
Australian Electrical News	696
Seeing the Heart Beat	696
Proceedings of Societies:—	
The Institution of Electrical Engineers	696
The Société Internationale des Electriciens	699
Correspondence:—Municipal Wiring and Free Wiring	699
Power Tenders for Motor Cars	700
The McDonald Battery and its Tests	700
Announcement	700
Electricity in Mines	700
Leyton Electric Lighting Works	700
Telegraphic Communication with the West Indies... ...	705
A Railway Through the Sea (*illustrated*)	701
Diamond Making by Electricity (*illustrated*)	703
Legal	705
Business Notices, &c.	705
Electric Lighting Notes	706
Electric Traction and Motive Power Notes	707
Telegraph and Telephone Notes	708
Contracts Open and Closed	709
Notes	710
City Notes	711
Traffic Receipts	712
Share List of Electrical Companies	713
Balata Industry of Dutch Guiana...	714
Applied Electro-Chemistry.—IV.	715
Variations in the E.M.F. of Clark Cells with Temperature ...	716
The Economy of the Modern Engine Room	717
New Patents	718
Abstracts of Published Specifications	718

THE

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FOREIGN PLANT AND ENGLISH COLONIES.

NOT many months ago we discussed at some length the Governmental Regulations issued from the Treasury at the Cape of Good Hope with reference to electric lighting and power undertakings. It is, however, out of the question to make a man moral by Act of Parliament, and it is equally beyond the range of practical politics to "regulate" an industry in such a way that only good and well designed plant may be used. So long as the safety of the public is ensured, the first object of a Government department is gained; the second thing that electric lighting regulations have in view, namely, the ensuring of a constant and proper supply, is best effected by the use of really high class generating and distributing plant. The Government at the Cape has wisely appointed a skilled electrical engineer as its adviser and electrician, and Mr. Trotter's removal from England to his sphere of labour in South Africa has been a gain to the electrical world at the Cape. That his experience would soon count for something out there we were certain, and the first sign was the issue of the Regulations to which we have already referred; another is the report which he has made upon the electric lighting of Cape Town at the request of the Town Council by permission of the Government.

Before dealing with the report itself and the lessons it appears to inculcate, we may briefly describe the plant at present in use. The generators are driven by water power, with steam power as auxiliary. The water comes from a large reservoir on Table Mountain, and passes through the turbines into a reservoir above Cape Town, from this the town is supplied. If the larger reservoir be full, and there is water to spare, it is run to waste. Distribution is effected on a five-wire system, with 440 volts between the outers. The principal cables are run overhead.

The report on the present condition of the plant is considered by public opinion at the Cape to show that things are not as they ought to be, and we think that anyone considering the facts brought to light will come to the same conclusion. The resident engineer appears to be entitled to no little credit for getting many of the weak points removed. We have a recollection of an advertisement appearing in the English press some time ago, stating that there was a vacancy for an experienced hydraulic and electrical engineer to take charge of this very plant, and from what we remember of the selection made, the Cape Town authorities got a very good man; but an engineer, however good he is, is always handicapped should he be put in charge of plant which is not up to the mark.

The specification issued to contractors seems in the first place to have been very vague. Everything was supposed to be of the best quality, and all workmanship of the highest class, and it was naturally expected that a complete, efficient

and thorough electric lighting system would be carried out; but the description of the various parts which the contractors proposed to supply, in conformity with this, were meagre in the extreme. Some £40,000 was to be paid, but what was to be given in return appears to have been ill-defined.

The turbines are described as of the impulse type with partial injection, of 200 brake H.P. each, with an efficiency of 75 per cent. They take about 1,000,000 gallons of water in 10 hours. At a time when 150 electrical H.P. was being generated, the water pressure was 500 feet, and the combined efficiency of turbine and dynamo 59½ per cent.; thus if 75 per cent. be assumed for the turbine, the dynamo was only of 80 per cent. efficiency. On the whole, however, the turbines seem to be satisfactory, and—a rather unusual thing—they are fitted with automatic governors which give little trouble. The auxiliary power consists of inverted compound steam engines of a type "inferior for the purpose of dynamo driving to English engines adapted for the purpose." Troubles have been caused by the eccentric straps of one engine seizing, by the slide valves being wrongly set, by slide valves cutting, by the absence of relief valves, and by the heating of the clutch rings on the dynamo shaft. Apparently, lifting tackle was not thought necessary, for no provision of this kind was made in the tender. In the boiler plant, changes had to be made with regard to the setting and in the fire-bars, while the absence of feed heater or economiser may be commented upon.

The dynamos have an unknown efficiency; one commutator has developed a flat, and the other seems to be on the road to a like result. The commutators, curiously enough, are of steel, and with reference to this we may cite the following remark, with which we think everyone will agree: "This is an example of German practice upon which I do not wish to express an opinion, other than that the behaviour of a copper commutator on a good English dynamo leaves nothing to be desired." From the generating station a trunk main, 2,500 yards long, runs to the distributing station; this main will carry the current from one dynamo only, the other evidently being spare. The average loss in the main is 18 per cent. In the distributing station an automatic switchboard is fixed; nominally a motor, which is always in action and does what regulating is necessary, but as it is seldom left to take care of itself, a man might as well be kept to regulate as to attend to the motor, especially as it absorbs 1 unit per hour, and cost £842. In the distributing station a secondary battery of 272 Tudor cells in wood-lead-lined cases, of a capacity of 1,404 ampere-hours, and capable of discharging up to 468 amperes, is fixed for balancing purposes and assisting the output at times of heavy load. Recently, two balancing dynamos have been provided, at a cost of £920, as the risk of depending wholly on the battery was fully realised.

The overhead wiring seems to be ill-conceived. The cables of opposite polarity are kept apart by wooden distance pieces, and no care has been taken to keep all line wires sufficiently far away from balconies and residential property to safeguard risk of fire. Gutta-percha insulated wire has been used in street lamp columns, with the result as might have been foreseen, that faults were of frequent occurrence. Armoured cables are in some cases used for underground lines. The plant may be tabulated as follows:—

Two 200-B.H.P. turbines of 75 per cent. efficiency.
Two auxiliary steam plants.
Two dynamos, giving 690 volts and 175 amperes.
One trunk main, to carry 175 amperes 2,500 yards with 18 per cent. drop.
One automatic switchboard for 400 amperes.
One battery, 272 cells of 1,404 ampere-hours, discharging at 468 amperes.
Two balancing dynamos.
"Air wires" or overhead network, costing £11,321 2s. 2d.

Total cost, £84,965. Works' cost p.a., £4,590. Total costs p.a., £8,000.

We now come to the lessons to be learnt from this report, and we think that they cannot be brought home too clearly to English manufacturers. As Mr. Trotter says, "Electrical inefficiency has been closely studied by English electrical engineers, and their methods are, in this respect, far in advance of electrical engineering in America or on the continent of Europe, where attention has not yet been carefully paid to this matter." Here we have a large city supplied by an electric lighting station with current through a single main under conditions that no consulting engineer of any experience would, we should imagine, permit for a moment. We should imagine that people supplied with electricity in this way would look upon breakdowns as being inseparable from electrical engineering work. In South Africa most of the electrical work is German or Yankee, for no reason than that our manufacturer either cannot or will not—they most certainly do not—take the trouble to work up a business, or to seize the opportunities that exist. First class English work is always appreciated in the Colonies. Thus we have recently perused an account of the works opened a short time ago at Launceston, Tasmania, where the contractors were the English firm of Siemens Brothers & Co., Limited, and, to judge from the apparatus employed and general tone of the designs, we should expect every success to attend these works. Far from depreciating foreign enterprise, we know that Englishmen have learnt, and will continue to learn, much that is of value from their *confrères* in the States and on the Continent, but in English-speaking colonies English engineering firms have a field which so far has been left too much to the busy foreign competitor, and the results are not always satisfactory to those who have to run, to pay for, or to utilise the plant. The foregoing description read by an engineer does not need many words from us to point a moral. If South African business were pushed there is a rich return to be won. The names of Messrs. Crompton and Messrs. Johnson & Phillips, to mention only two that occur to us, are not unknown in the electric lighting or power transmission business in the Transvaal and other parts of South Africa, but in Cape Town, of all places, a German firm is given the contract on account, we believe, of the "go" with which it was sought rather than owing to any superiority of plant or designs.

The technical and lay Press are ever pointing out that the markets of the world are open to all, but that those who most nearly meet the conditions of the buyers will obtain the business. The German meets his prospective client by speaking to him in his own language, by giving him literature he can read without any trouble, and by meeting his ideas in the way of weights and measures. When the order has been obtained and the goods delivered, it may be found that, particularly in electrical engineering, there is something further to be said. The high efficiency, general adaptability, and good engineering design of English plant, will recommend the maker when once the appliances are before the purchaser, but to reach this desirable stage the market must be sought, and our trade competitors fought on their own ground.

ON DREHSTROM MOTORS WITH REDUCED SPEEDS.*

It is known that asynchronous drehstrom motors have a tendency to run with a speed approaching synchronism. In order that a current be produced in the rotating part, it is necessary that there should be a loss of revolutions. Leaving the stray field out of account, it may be said that the current and the turning moment of the motor is proportional to the number of revolutions. The energy imparted to the armature divides itself into two parts: the mechanical part and the heat produced. The heat produced by the current is to the mechanical work, in the same ratio as the loss of revolutions is to the total number of revolutions. For instance, if

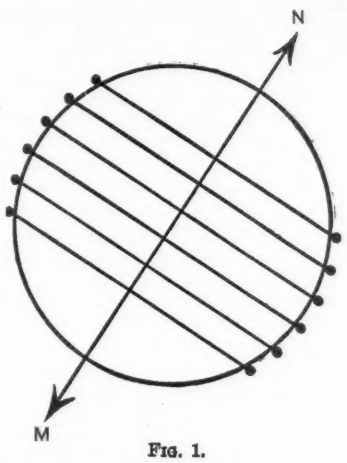


Fig. 1.

the motor lose 5 per cent. of revolutions, then 5 per cent. of the energy transmitted to the armature is converted into heat. If 50 per cent. of the speed is lost, half of the transmitted energy is converted into heat in the armature. Herein arises one difficulty of running these motors at low speeds.

This law, as has been shown by Herr Knauth of Messrs. Siemens and Halske, holds exactly only for a drehstrom motor, with an ideal drehfield and a short-circuited armature with

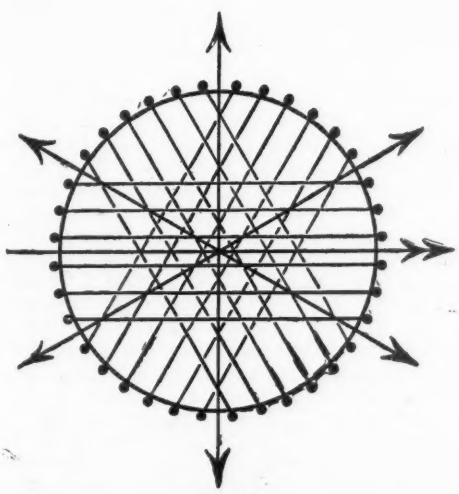


Fig. 2.

an infinite number of rods. Besides the deviations due to imperfections of construction, Görges has discovered a quite new and highly intereresting phenomenon which has an important bearing on this question.

Let the fixed part of a two pole drehstrom motor, says the author, be arranged as usual. The cylindrical iron armature, fig. 1, is wound with a short-circuit coil, so that it is magnetised in one direction, M N by the currents in the coil. Such a winding may be called *uniaxial*; similarly a winding, fig. 2, consisting of three coils, as is common on drehstrom armatures with rubbing rings, may be called *triaxial* winding.

It has been observed when an armature with an unaxial winding is employed, that, with a given turning moment, the armature turns with two different speeds, namely, at about full and half speed. If the motor is brought to synchronism and allowed to run free, it behaves like an ordinary drehstrom motor. It runs with nearly synchronous speed, and has a loss of speed proportional to the load. If, however, the machine is overloaded, the speed suddenly falls to one-half, and runs now with a loss of turns depending on the load, as if the half speed now corresponded to synchronism. When running exactly at the half speed, the turning moment is zero. And it is still more remarkable that when the motor is driven at a higher speed than half speed, it becomes a generator and gives back electric energy to the external circuit. It is found that the motor has a much greater turning moment at half speed than at the full speed.

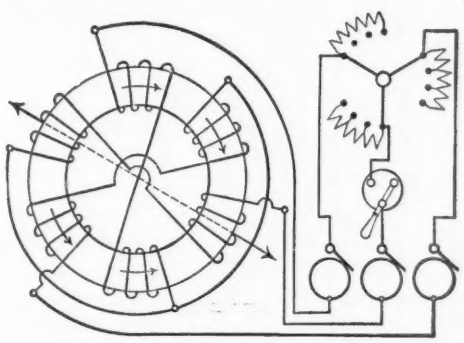


Fig. 3.

A triaxial winding can be easily converted into an unaxial winding. It is only necessary to break one of the circuits of the armature. As is shown by fig. 3, the two remaining coils magnetise the armature ring in the same direction.

A drehstrom motor with three rings and a switch was arranged to work a lift. The motor made at synchronism 1,500 revolutions per minute. If, however, one brush was raised from its ring, the cage ascended with half the speed. When the lift reached the top the motor was reversed. Gravity now helped the motor to pull the cage down, and as soon as it attained a speed of 750 revolutions per minute the motor began to act as a brake, and the cage thereafter sank down at a uniform speed.

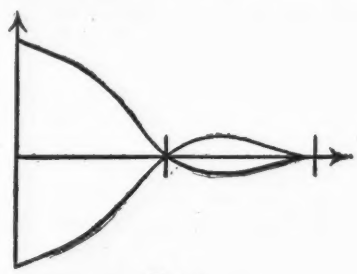


Fig. 4.

The explanation of this phenomenon is by no means simple. I have, however, attempted to make clear by calculation the relation of the turning moment and the current heat in the armature to the speed, and have obtained the curves represented in fig. 4 for the turning moment; the maximum and minimum values of the turning moment being given for each number of revolutions. From this it appears that the motor at any speed can act either as a motor or a generator. Only for the half and the full speed is the turning moment exactly zero. As a matter of fact, one case has been observed in which the motor with unaxial winding has come up to the full number of revolutions. This would be possible according to the curves, if, at the instant, when the motor has attained its half speed, the primary machine slackens speed a little.

* Hans Görges in *Elek. Zeitsch.*, p. 517, 1896.

The heat generated by the current with the unaxial winding is, according to calculation, about a third of that with the triaxial winding, *i.e.*, the motor gives a much higher efficiency with the unaxial winding. With a 5 H.P. motor having a normal efficiency of about 80 per cent., the efficiency at half speed with the triaxial winding was 40 per cent., while with the unaxial winding it was 60 per cent. The heat generated by the current in the armature was 2,083 watts with three brushes, and 434 watts with two brushes. The phase displacement with the half speed, is, of course, very great since the magnetism remains the same.

The above described phenomenon is evidently only a special case of a much more general group of phenomena. I remember making experiments with a drehstrom motor about a year ago, which showed a speed of 150 to 200 revs. per minute instead of 1,500. The phenomenon was not at the time further investigated. I am convinced that an armature with a polyaxial winding can run at different speeds according to the number of axes; only these speeds would not, as a rule, be sufficiently stable to be of practical value.

It should be added that an asynchronous uniphase motor behaves in a similar manner, and that it also acts as a brake on a lift, when the speed exceeds the half of synchronism.

It is evident that this phenomenon may have a great practical value as well as theoretical interest. Siemens and Halske have already made use of it in some installations, such as in the driving of pumps where sometimes more and sometimes less water is required. It is also evident that the discovery will be of great importance in electric railways, when three-phase working of street railways comes into more general use.

A "NEW" FORCE.

There are few more pitiful spectacles than that of a man who triumphantly announces to the world his discovery of something which everybody has been familiar with for years. It is even worse than that of the callow youth who ventures a "Joe Millerism," thinking it a fine flash of wit, and expecting everybody to laugh. Much may be forgiven the scribbling journalist, who has to make his living, very often, by evolving "copy" out of his inner consciousness; but for a man who claims to be a scientist, and who enjoys the proud position of Lecturer on Chemistry and Physics to the London Conservatoire of Music, &c., and who comes forward with a flourish of trumpets, announcing as new that which most people have been acquainted with for 20 years past, we can have but little sympathy.

Mr. W. Lascelles-Scott has been to America, and he wants all the world to know it. He wishes everybody to understand that the object of his visit was the investigation of "a new force which has recently been discovered" by no less a person than our evergreen old friend, John W. Keely, of Philadelphia; and he implies that he, Mr. W. Lascelles-Scott, alone of all great scientists on this side of the water, was chosen to investigate, and pass judgment upon, this latest triumph of inventive genius, which is going to revolutionise the workshops of the world.

In a letter to the Editor of the *Globe*, November 10th, Mr. W. Lascelles-Scott describes how he went recently to the United States at the "direct instigation of Mrs. Bloomfield-Moore," to investigate the discoveries and inventions of John W. Keely, and is careful to explain how he stipulated for "perfect liberty of action," and how he commenced his investigations with "a perfectly open mind which harboured no predilection or prejudice" against the subject of his inquiry; and how he studiously avoided any, and all, aspects of the question which might "tend to encourage stock-jobbing speculations or financial speculations of any kind." What an admirable attitude! And how well the statement of it prepares the mind of the expectant reader for the wonderful results which followed this scientific inquiry.

Mr. W. Lascelles-Scott then proceeds to describe how he "inspected the workshops of Mr. Keely, and witnessed several important demonstrations of the *etheric force*," which has now been "harnessed and controlled;" and how the inventor submitted his appliances to such tests as he, Mr. W. Lascelles-Scott, deemed expedient. He does not pretend, of course, to give even a full outline of the work and theories of the man Keely. Indeed, he says, "his own explanations, whether written or verbal, are invariably couched in such, to any European scientist at least, hopelessly obscure language, that to my thinking they tend to confuse quite as often as they do to elucidate." In spite of this, however, Mr. W. Lascelles-Scott has no hesitation in stating that J. W. Keely has certainly discovered a *new* force.

The investigator appears to have been very much impressed with the courtesy and frankness of the inventor, and he certainly exhibits a considerable amount of admiration of him as a man.

After expatiating upon the facilities freely accorded him for conducting his great research, Mr. W. Lascelles-Scott proceeds to give an account of the "vibrodyne" which is "actuated by a sympathetic negative transmitter, to which it is connected by German silver wires," the transmitter itself consisting of a hollow brass globe containing a *Chladna*, at the base of which was fitted a "*harmonic nautilus*." When certain notes were struck upon this nautilus, the vibrodyne "began to move slowly, and gradually increased until it acquired a velocity of from 85 to 90 revolutions per minute," and the learned English scientist, who saw this with his own eyes, "estimated its driving power as equivalent to a pull of over 80 lbs." As a proof that he really witnessed this wonderful motor working, Mr. W. Lascelles-Scott triumphantly brought home with him, all the way from Philadelphia, a portion of the wire actually employed. What could be more convincing?

Poor Mr. W. Lascelles-Scott! To think that he should have travelled so many thousands of miles to "investigate," and then describe as new, that which most reading men have been familiar with for the past 20 years. Is it possible that a lecturer on physics at the London Conservatoire of Music can afford to dispense with the Electrical Review? (May we be forgiven our egotism!) Is it possible that, having come into such close contact with Mrs. Bloomfield-Moore, whom, we are credibly informed, has given up Keely and all his works in disgust, after having spent thousands of dollars upon him, and yet cannot have heard from her of the scathing criticisms which scientists and intelligent business men, too, have passed upon this prodigious bogey? Perhaps Mr. W. Lascelles-Scott's surprising innocence is due to the absorbing character of those scientific researches on which, possibly, he spends his days in the seclusion of his home, only emerging to lecture on Chemistry and Physics before the London Conservatoire of Music. Though we may spoil his transitory triumph by pointing out that he has only re-discovered that with which most reading people have been familiar for years, he will still have left to him the memory of a pleasant little trip across the Atlantic, which, from the second sentence in his letter to the *Globe*, may be inferred to have been taken at the expense of somebody else.

Mr. W. Lascelles-Scott is evidently not disposed to belittle himself. "Sweet are the uses of advertisement," as Shakespeare might have written had he lived in these degenerate days. Once upon a time this gentleman actually wrote an article in the *Nineteenth Century* on "Modern Explosives," in which he had something to say about sympathetic vibrations. He cannot forget it, neither can he resist the temptation of reminding readers of the *Globe* that he it was who did this thing. We remember that article, and we know, too, how it was made, and we dare assert that there is nothing of value about sympathetic vibration or anything else in that article, which Mr. W. Lascelles-Scott cannot forget, which cannot be found in Berthelot's well-known work on explosives.

A little while ago we thought we had driven the last nail into the coffin of John W. Keely and his ridiculous "motor," and now we find that Mr. W. Lascelles-Scott has ventured to prise open the lid again. He thinks he is a great discoverer, but he is only a resurrectionist, and we are very sorry for him.

NOTE ON THE PRESSURE OF THE TROLLEY WHEEL AGAINST THE WIRE.*

By HERMANN S. HERING.

While making some tests on the losses in trolley and rail contacts, it was observed that the pressure of the trolley wheel against the wire was a very important factor in producing or preventing the sparking, and varying the losses resulting therefrom.

Questioning revealed the fact that little or no attention had been paid by superintendents to the tension of the spring in the trolley base, except to prevent its being very loose or very tight. It was usually allowed to remain as originally adjusted, except an occasional tightening when it got too loose. Only one mechanic of the many interviewed had noticed any connection between the pressure of the trolley, its sparking and its liability to jump off. He said he had often found that tightening the spring would remedy the sparking of a trolley sent in for repairs, and that he tried to keep the pressure uniform. No one else connected with any of the roads seemed to have paid much attention to the subject. Some tests were undertaken on four prominent roads and measurements made of the pressure of the trolley on over 100 cars. In a preliminary test it was determined that although sparking was sometimes caused by a bad wheel, it was more often due to insufficient pressure. Observations were taken with new and old wheels, and each would spark with the spring slackened and cease when it was tightened. In order to produce continuous sparking the wheel must be very bad and the spring very slack, but sparking at the hangers occurs at even a moderate pressure, especially when a bad form of hanger is used.

In addition to sparking less, the trolley stays on the wire better with a higher pressure, which is a very important feature especially on curves, switches, and cross-overs. This is a natural result, as the wire will hug the groove more closely and have less tendency to leave it. On some roads in Europe the trolley wire is supported on chains or flexible hangers, and the pressure of the trolley made great enough to support and raise the wire so that it virtually rests upon the trolley wheel. This practically prevents any jumping off and sparking, and permits smooth elastic running without the bumping felt with rigid hangers.

It has been claimed that the increased pressure injures the overhead work where the trolley strikes the hangers, cross-overs and switches, but observation has not shown this to be the case, except on roads having very poor overhead construction.

Objection was also made on account of the difficulty of getting the trolley back on the wire in case it does leave it. With sufficient pressure, it will rarely jump except where the overhead work is defective, and the sooner this is found out and remedied the better.

The tests showed the pressure to vary from 9·3 to 33·8 lbs., and the averages on four lines were from 15·4 to 30·8 lbs., which is quite a wide range. The best results seem to be obtained with a pressure of about 20 to 25 lbs. Less than this renders the trolley liable to jump and spark, and more, makes the trolley unnecessarily difficult to manage. With 10 lbs. or less a good wheel is very apt to spark and jump, and a bad wheel almost sure to: even with 15 lbs. the liability is not removed. The sparking of a bad wheel with 16½ lbs. pressure, for instance, was stopped when the pressure was increased to 21 lbs.

For the last few years the makers of trolley bases have supplied stronger springs, as they have been recognising the advantages, but the older forms had springs producing from 7 to 15 lbs., as the effectiveness of greater pressure had not yet been recognised.

In addition to those already mentioned, tests were made of the pressure of the trolley at various heights, the difference between the pressure produced when the trolley was raised or lowered, and the difference between the vertical pressure and the force required to pull the trolley obliquely.

The method of making these tests consisted in using a spring balance reading to 35 lbs. in quarter-ounces and hooking it into a loop tied in the trolley wire at a convenient height. The balance was then pulled until the trolley just left the wire and a reading taken, each determination being made four times. The observers stood behind the car and pulled the rope, so that it just cleared the edge of the roof.

To determine the pull at various heights, a tape line was fastened to the trolley wheel and the spring balance used to pull the rope vertically, but in this case the trolley base was turned slightly to one side of the car to give clearance to the rope.

The method of weighing the car on track scales, with the trolley on and off, was also tried, but besides not being sufficiently accurate, on account of the value being so small an amount compared with the total weight of the car, this method was too slow and cumbersome.

The difference in pressure between the trolley moving up and moving down is quite considerable, and in making tests this factor must be borne in mind. This difference varies from 3½ to 10 lbs. Fig. 1 contains the results of some tests made on two makes of bases, the T.-H., used by the General Electric Company, shown by solid lines, and the Baker base, shown by dotted lines. Curves marked *b* are the values obtained when pulling the trolley down, and curves marked *a* when allowing it to rise. In the first case the pull is the sum of the tension of the spring and the friction, and in the latter it is the difference, and necessarily smaller. Readings were taken every foot from 12 to 23 feet above the rails. The values given are for vertical pressure. The height of the trolley wire above the rails varies from 17 to 21 feet, but averages about 19 feet.

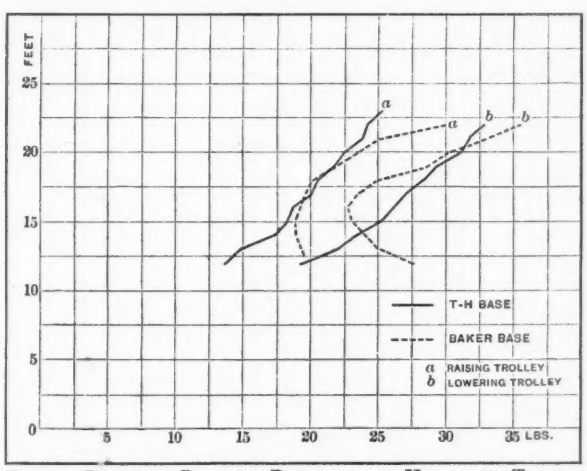


Fig. 1.—Relation Between Pressure and Height of Trolley.

The curves show decided characteristics, the pressure in the one steadily increasing with the height, and in the other reaching a minimum at about 15 or 16 feet, and then increasing again.

In order to compare the vertical with the oblique pull, the tension of the trolley rope was measured in the two cases, the oblique angle being that produced by the rope just passing the rear edge of the roof of the car. The trolley was 19 feet above the track in all the tests. With a Westinghouse base the vertical pull on the rope averaged 19·8 lbs., and the oblique 18·1 lbs., being 91·5 per cent. of the vertical; with a new Westinghouse base but slightly used, the vertical pull was 34 lbs., and the oblique 31·5, 92·7 per cent.; with a Baker base the vertical pull was 19·5, and the oblique 17·9 lbs., 92 per cent. The T.-H. base gave the same result as the Baker.

Table I. contains the pressures determined on 101 cars. Many more tests were made, but these are given as being typical. Each value in the table is the mean of four readings. The tests on any one road were made on the same day, the observers being stationed at the terminus, and making the measurements during the lay-overs. The values given are the pressures perpendicular to the wire.

With the Westinghouse bases the pressure varied from 16·9 to 33·4 lbs., mostly from 17 to 22, and were somewhat irregular, the average being 21·6 lbs. The cars giving high

* New York *Electrical World*.

values of 30 lbs. and over had new equipments or new springs. Cars Nos. 210 and 225 had new bases, and No. 215 had its spring tightened. The conductors on this line favoured a pressure of about 21 lbs. With less than this they had trouble with the trolley jumping off, and more, made it hard to put the trolley on if it did jump off, which seldom occurred.

On the cars having a new equipment of Westinghouse bases, the pressure varied from 24·5 to 33·8 lbs.; only two readings were below 30, the rest being very uniform. The average was 30·8, and the conductors complained of the tension being too strong. The trolley seldom jumped off, however.

On the cars using the Baker bases the pressure varied from 11·3 to 21·9 lbs., mostly between 15 and 18, the average being 15·9 lbs. These were very uniform, as the superintendent of the shops endeavoured to keep them so, though he had no spring balance with which to measure them. The other roads made no attempt at regulation.

The pressure on the cars using the T.-H. bases was very irregular, and varied from 9·3 to 29·1 lbs., a very wide limit. The average was 15·4 lbs. The trolleys jumped and sparked a great deal, and the overhead construction was not especially good. Cars Nos. 3, 5, 6, and 10, were Summer cars with new bases, and car No. 12 had a new Westinghouse base, which accounts for these pressures being so far above the average. Had the tension of the springs been increased and kept more uniform, most of the trouble would have been avoided.

Table I.—Pressure of Trolley against Wire.

Style of base.	Car No.	Pressure in lbs.*	Car No.	Pressure in lbs.	Car No.	Pressure in lbs.	Number of cars tested.	Average pressure.
Westinghouse.	213	19·3	214	24·0	206	23·9	32	21·6
	231	20·3	215	33·4	227	23·6		
	221	19·2	216	23·8	209	18·6		
	233	20·7	217	19·9	223	20·8		
	219	20·4	218	19·1	229	28·7		
	210	27·0	201	19·3	211	21·5		
	327	18·4	230	20·4	212	21·7		
	310	16·9	220	17·8	224	20·8		
	226	19·5	202	19·7				
	225	33·2	203	18·7				
	222	19·7	204	23·3				
	228	18·7	205	20·6				
Westinghouse (new equipment).	416	32·8	415	24·5	413	32·4	9	30·8
	411	33·4	410	30·3	414	27·3		
	412	31·3	425	31·2	409	33·8		
Baker.	238	16·4	113	16·0	247	14·5	30	15·9
	291	15·6	242	14·8	237	13·3		
	245	16·8	288	17·9	232	16·0		
	281	14·7	288	18·5	293	16·7		
	282	17·3	246	12·8	235	14·3		
	123	17·8	118	17·7	240	17·0		
	234	15·8	280	15·0	233	15·9		
	236	17·7	241	12·6	239	15·8		
	248	16·8	213	17·7	111	15·2		
	284	21·9	249	16·1	244	11·3		
Thomson-Houston.	63	15·0	51	16·1	59	16·3	30	15·4
	74	18·9	8	11·3	39	10·4		
	6	29·1	25	12·9	31	10·4		
	52	17·3	62	14·6	30	9·3		
	71	15·7	5	24·0	34	13·1		
	13	18·1	53	17·1	27	12·2		
	64	14·0	73	14·6	26	9·5		
	56	14·6	14	15·5	3	14·6		
	16	13·5	12	23·7	2	14·2		
	70	15·5	7	13·1	10	18·7		

* Pressure given perpendicular to trolley wire.

The observations were made by Messrs. Charles Reutlinger and B. Harrison Branch, the two students who assisted the author in preparing the article on "Electric Car Tests," which appeared in the *Electric Railway Gazette*, August 31st to November 23rd, 1895.

ELECTROLYTIC COPPER AND SILVER REFINING.

Few electricians are aware, says the *American Electrician*, of the vast proportions which the industry of the electro-deposition of metals has assumed within the past few years. In 1894, 57,500 tons of copper, or almost one-third of the entire copper output of the United States, was electrolytically refined; since then there has been a large increase, and at the present time not far from one-half of all the copper produced in this country is refined in the electrolytic bath.

One of the latest electrolytic refining plants erected in this country is that of the Guggenheim Smelting Company, at Perth Amboy, N.J., which has an annual capacity for about 10,000 tons of copper and 30,000 ounces of silver, and is equipped for the most modern processes of refining. The copper here refined carries a large percentage of gold and silver, and the silver parting plant also handles the precious metals separated from a rich lead bullion that undergoes a final heat metallurgical process at these works. The refinery is in operation 365 days in the year.

The copper is received at the works in bars, having already undergone the process of raw smelting from the ore and concentration from the resulting matte. At the works the metal is again heated in reverberatory furnaces and then cast into anodes for the electrolytic bath. Before commencing a description of the final or electrolytic process, the electrical generating plant will be considered.

Electrical Generating Plant.—The boiler plant consists of five Babcock and Wilcox boilers rated at 125 H.P. each, and generating steam at 150 lbs. pressure. The dynamo generating plant consists of two systems—one supplying current for the commercial copper depositing baths, and another for the electrolytic manufacture of cathode plates whose object will be explained later.

The commercial plant consists of two Porter-Allen triple-expansion condensing engines, running at 250 revolutions per minute, and driving two General Electric generators. The generators are of the eight-pole multipolar type, each of a capacity of 180 kw., and delivering 1,500 amperes at 120 volts; they are shunt wound, with smooth core armatures of the ring type.

With generators for this service, the matter of brushes is an important one. In the present instance good satisfaction is being given by woven wire brushes, of which there are three to each brush-holder, or 24 in all, the cross section of each brush being $\frac{7}{16}$-inch × $1\frac{3}{16}$-inches.

The cathode system is supplied by a General Electric generator, specially designed for the plant. It is a four-pole machine with a capacity of 12 kw., and delivers 1,000 amperes at 12 volts; the field is separately excited from a 110-volt power circuit. The commutator is 24 inches in length, 14 inches in diameter, and contains 40 segments, each $1\frac{1}{16}$-inch wide. The brushes, 64 in number, are of carbon containing a copper wire core; the cross section of the brushes is $1\frac{1}{4}$-inch square. The cathode generator is driven by a Standard 25 H.P. Westinghouse engine.

In addition to the electrolytic dynamos, there are two four-pole 40 kw. power generators and one 40 kw. 110-volt incandescent lighting generator. A considerable number of electric motors are employed for various purposes, their power ranging from 50 to $7\frac{1}{2}$ H.P. Two Otis freight elevators, a Shaw crane, and desilverising kettle stirrers are operated by electric power.

The Cathode Baths.—In the system used at the Guggenheim refinery, the copper is deposited on special cathode plates, which plates are prepared in a system of tanks separate from the commercial tanks. Rolled copper sheets, $\frac{1}{10}$-inch thick, receive the cathode deposit, which is permitted to become $\frac{1}{25}$-inch thick, both sides of the rolled copper being thus plated. Wood strips form a frame about three sides of the plates; after the two surfaces are oiled and covered with graphite in order to prevent the cathode deposit from sticking, the plates are placed in tanks between commercial anodes, and after the necessary thickness of copper is deposited, the shells are stripped from the plates and are ready for use as cathodes in the commercial tanks. There are 30 cathode tanks, each 8 feet 6 inches long, 3 feet deep, and 2 feet 6 inches wide. The cross-section

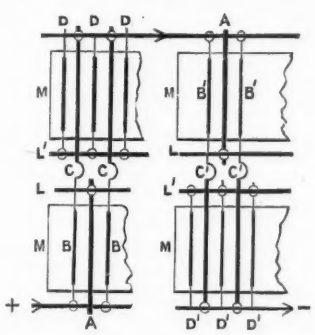
of the conductors supplying current to the tanks is 1¼-inch square.

The Commercial Baths.—The tanks are arranged in terraces, the object of which is to facilitate circulation of the electrolyte. There is a difference of level of about 2 inches between each row of tanks, and an overflow pipe of the necessary diameter keeps up a sufficient circulation to maintain the electrolyte in proper condition—there being a constant supply of new fluid to replace that drawn off. The tanks, which number 360 in all, are of 2-inch pitch pine coated with "P. & B." paint, each being 9 feet 10 inches long, 3 feet deep, and 2 feet 6 inches wide. The electrolyte, as prepared for the bath, has in solution, by weight, 16 per cent. of bluestone and 5 per cent. of free sulphuric acid. Samples from the tanks are frequently tested in order to ensure reliability of result.

Each tank contains 22 anodes and 23 cathodes. The anodes for electro-deposition are 2 feet 6 inches long, 2 feet wide, 3 feet 2 inches across the lugs, and 1¼ inches thick.

All of the 360 tanks are in series, and the plates of each tank are in multiple. On the outer side of each tank is a copper bar 1¾-inch square in cross section, and on the inner a wooden bar, which together form the supports for the anodes and cathodes; the two outer bars of each pair of tanks are the + and − conductors. The tops of the cathodes are bent as in fig. 4, and hang from cooper cross bars, while the anodes are supported by their lugs.

The tanks are arranged in pairs, as shown in the figure. M, M, M, M, are the ends of tanks, the supporting and conducting bars above referred to being represented by the heavy horizontal lines. The heavy vertical lines represent the



anodes, and the lighter vertical lines the cathodes. The small circles under one end of each cathode and anode is a square porcelain insulating block, the object of which will be apparent from the next paragraph.

Referring to the figure, current enters the lower tank to the left through its 22 anodes in multiple, of which one, A, is shown; the cathodes, it will be seen, are insulated from the positive conductor. The current then proceeds through the bath to the adjacent cathodes, B, B, and then, by means of the connectors, C, passes to the anodes of the second bath; then continuing through this bath, it enters the cathodes, D, passes to the extreme conductor, and enters the next pair of tanks, in which its course is the same as that just described.

It will thus be seen that the tanks of each pair are in series the same as the adjacent pairs of tanks. In the actual tanks the connectors, C, are plates of copper 6 inches long, 2½ inches wide, and ⅛th inch thick, supported on the two wood bars, L and L′, the end of a cathode and anode bar, respectively, resting on each plate.

The anode and cathode plates are separated by about 1¼ inch. The current density is about 10 amperes per square foot (counting both sides of the anode plate), and it requires about 24 days of 24 hours to electrolytically transfer the copper of the anode to the cathode plate, the weight of the former being about 275 lbs. The density of the current varies with the richness of the anode in precious metals; if a large quantity is present, a high density would carry part of the silver to the copper. In very pure copper a density as high as 10 and even 20 amperes may be carried. The voltage, of course, depends only upon the ohmic resistance of the electrolyte, conductors, and plates. With 356 tanks (four tanks are always out of circuit, having "slime" removed and being otherwise cleaned), the voltmeter at the switchboard registers from 117 to 120 volts with 1,500 amperes.

At Perth Amboy, the copper refined is usually rich in precious metals, carrying at times 600 ounces of silver and 4 ounces of gold to the ton of copper. If the current is kept at the proper density, all of these metals, together with impurities like bismuth and antimony, are deposited in the bottom of the tanks in the form of a black slime, which name it goes by in the refinery. This slime is carefully gathered and passed through chemical and heat reducing processes, which remove most impurities and concentrate the silver and gold; the latter is then ready for what is known as the electrolytic "parting" process. At the Perth Amboy works, lead carrying silver and gold is also refined, and the precious metals from the lead and the copper are united in one of the final processes of concentration preparatory to electrolytic "parting."

Silver Parting Plant.—The silver refining process used at Perth Amboy is that of Dr. B. Moebius, and is very interesting in its various details.

The peculiarity of the Moebius process consists in the employment of a belt for the cathode, which belt is always kept in motion, and from whose surface the silver deposited from the anodes is continuously removed by scrapers located at one end of the tank. The belt is made of a sheet of pure rolled silver, 15 inches wide, 31 feet long, and weighing about 40 lbs. Its upper portion passes about ½ inch beneath the lower surface of the anodes; the belt is given a motion of about 3 feet per minute.

There are 48 Moebius tanks in the silver parting plant, grouped in eight sets of six tanks each. The tanks, which are made of 2-inch pitch pine coated with acid-proof cement, are 14 feet 3 inches long, 16 inches wide and 7 inches high, and are arranged in tiers of three.

In each of the latest type of tank there are 24 wood frames 1 inch deep, each of which contains an anode; over the bottom of the frames a muslin diaphragm is stretched, and the anode rests on four hickory cross rods about ½ inch above this; the cathode belt passes about ½ an inch below the diaphragm. The anodes are 12 inches long, 3 inches wide, and ½ inch deep, containing usually 100 ounces of silver and from ·3 to ·8 ounces of gold. The anode contact levers shown in the illustration are tipped with platinum; the cathode contacts are shown to the right of the cut, and consist of silver brushes bearing on the cathode belt. To the left of the tank is a revolving scraper or brush which, as the surface of the belt passes over it, removes the deposited silver and permits it to fall into the hopper shown in the illustration.

The electrolyte consists of nitric acid (38 Baumé) having dissolved in it granulated silver; some nitrate of soda and nitrate of copper are also added when starting up with a new solution.

A General Electric generator supplies 200 amperes of current; the voltage depends upon the strength of the nitrate solution and the length of time the anodes have been in circuit, but averages about 90 volts. All of the 48 tanks are in series, and the anodes of each tank are in parallel. The capacity of each tank is 600 to 700 ounces of silver per 24 hours.

The residue from the anodes is principally deposited on the muslin diaphragms, and consists of gold, bismuth, lead and antimony. The former metal is finally recovered from the residue by chemical means.

THE ACHIEVEMENTS OF PHYSICAL CHEMISTRY.

"Physical chemistry is the chemistry of the future." These words quoted from an address by Prof. Du Bois-Reymond, were used by Ostwald 10 years ago in the introduction to the first number of the *Zeitschrift für Physikalische Chemie.* In using these words, Du Bois-Reymond looked forward to a time when it shall be possible to give a mathematical expression to all forms of chemical knowledge. The picture in his mind seems to have been that of a sort of astronomy of the atoms, in which the motions and forces within the molecules shall be known very much as are the motions and forces within the planetary system.

D

So far as any practical realisation is concerned, the thought is still only a poetic fancy, and whatever progress, if any, may have been made, comes to us from organic rather than from physical chemistry. Indeed, it seems to have become the fashion on the part of several leaders in physical chemistry to speak slightingly of the atomic and molecular theories. Their thoughts appears to be that it would be better to confine ourselves to the purely empirical and mathematical concept of the atom and molecule, and leave the idea of particles which have an actual independent existence entirely in abeyance. It would doubtless be possible to give such definitions of atom and molecule as shall include only the results of our actual empirical knowledge and mathematical deductions therefrom. Such definitions would stand on a basis which is incontrovertible, and it is inconceivable that even the overthrow of the atomic theory, or any knowledge which may be gained in the future as to the nature of matter, could change them.

That such definitions possess great value is certain; and that it is very important to distinguish sharply between our positive knowledge, and speculations and theories based on that knowledge, everyone will admit; but, after all, unless we join that school of philosophy which teaches that there is no real existence outside of our own minds, there is some reality at the basis of and behind all the phenomena which we investigate. And it is the province of science to find out the truth about every real existence of which we can secure any tangible evidence. Our knowledge of atoms and molecules as actually existing particles is, doubtless, a purely speculative deduction from a multitude of diverse phenomena, and yet the mental picture connected with the concept has been, and still continues to be, of very great value in the development of our science. These mental pictures are vague, and in many respects incomplete, it is true, and they doubtless do not correspond closely to the real existences for which they are, at present, our best expression; but, to one familiar with the very practical results which have been obtained in the domain of structural chemistry, it is difficult to conceive how such results would have been possible without their use.

While physical chemistry has made little or no apparent progress toward the goal marked out by Dr. Du Bois-Reymond, its practical achievements during the last 10 or 15 years have been very considerable. These practical achievements of physical chemistry recently formed the subject of an address by the Vice-President before Section C of the American Association for the Advancement of Science, an association which seems to have been modelled upon the lines of our own British Association, but with the picnic element left out. Whenever the subject of physical chemistry is mentioned, our thoughts naturally turn to the subject of solutions, in as much as practically all the knowledge of that mysterious borderland which exists as an undefined track between the domains of physics and chemistry have been one in the study of solutions. We are not making too strong a statement when we say that up to about 11 years ago our knowledge was almost entirely of an empirical character. No great generalisation, similar to those which had long been known for gases, had been discovered. In 1885, J. H. van't Hoff proposed his theory of osmotic pressure. This was an epoch making event, and taken in connection with Traube's discovery of true semi-permeable membranes, and Pfeffer's preparation of such membranes in the interior of a solid partition, its importance cannot be over-reached.

Everyone recognises, of course, that the laws which have been given for osmotic pressure are identical with the laws of Boyle, of Charles, and of Avogadro. Van't Hoff pointed out this analogy very clearly, but he did not give any clear explanation of what he considered as the real cause of the phenomena of osmose. He spoke from the purely empirical side of the attraction which the solution exerts for pure water. Ostwald, in his Lehrbuch, is even more careful. He speaks of the cell as conducting itself as though there is within it a partial vacuum for water. These expressions are very similar to those of the older text-books, which speak of the expansion of gases as due to the repulsion of their particles for each other, and appear to be equally misleading and unsatisfactory. In a later paper, in reply to a criticism by Lothar Meyer, van't Hoff gives a clearer explanation in terms of the kinetic theory. The lecturer, W. A. Noyes, here gave a précis of this theory. He also pointed out that van't Hoff has rendered other services apart from these phenomena of osmose, and, as a practical result, we now have at our disposal a larger number of methods for the determination of the molecular weights of solid and liquid bodies. The work of Raoult in this field was also mentioned, and the use which Victor Meyer made of his results was also referred to.

(To be continued.)

McDONALD'S BATTERY AND ITS TESTS.

(Concluded from page 654.)

We come first to the report by Mr. R. R. Tatlock, Public Analyst and Gas Examiner for the City of Glasgow, which we reproduce:—

"The following results were obtained with Mr. McDonald's cell, and side by side are those obtained with an ordinary Daniell's cell:—

	McDonald's.	Daniell's.
Amperes (average)	5·2	0·17
Ampere (hours) total	124·8	16·49
Volts (average)	1·10	1·10
Watt (hours)	137·3	18·96
Hours required to exhaust ...	24	97
Sulphate of copper used during 100 watt-hours	10·9 ozs.	24·2 ozs.
Chloride of sodium used during 100 watt-hours	6·2 ozs.	...
Sulphate of zinc used during 100 watt-hours	...	7·3 ozs.
Amperes (average) for first five hours	9·6	0·33
Amperes (average) for first 10 hours	8·3	0·30

"As in the above statements full details are given of the quantities of chemicals required for each cell, and also the results of the observations, it is unnecessary to give any special comparison between the two cells."

As there is no mention of the dimensions of McDonald's cell compared with the *ordinary* Daniell, nor is the weight of zinc consumed in McDonald's cell given, we fail to see how any fair comparisons of the two batteries is to be obtained. And what kind of porous pot was used, hard or soft; if the former, which seems likely to have been the case, the cell so made up was quite useless as a standard for comparisons of this kind. That the Daniell was extraordinary, rather than ordinary, in its very badness, seems evident from the tests of Dr. Peddie, to which we shall now refer. In his first test only the current strength was measured of a cell 12 inches high and 4 inches square. It was run for about 7 hours, and the number of ampere-hours obtained was 59·88. The experiment was continued the next day, as during the interval the cell had recovered to some extent *from the state of polarisation reached on the previous day* (the italics are ours), and this is the cell in which it is claimed that polarisation has been eliminated! The initial value of the current was 9·4 amperes; but the strength steadily diminished, till in 4½ hours it had dropped to 2·034!

On the third day another run of 2½ hours was taken, but on this preliminary trial it is not necessary to make any further comments; the second test is more to the point.

In this the cell was entirely recharged and then discharged continuously during 12 hours, both current and voltage being recorded. The external resistance was 0·024 ohm (a galvanometer only), except when for a few seconds at a time, a further resistance of 0·0633 ohm was added for the purpose of determining the voltage and the internal resistance of the cell. As the result of the action *during the first test*, the carbonaceous material used in the cell was coated to a considerable extent with copper, so that the internal resistance was diminished. Starting with a value of 15·84 amperes, the current fell in 4 hours to 7·2, in 5 hours to 4·95, in 10 hours to 1·44, and in 12 hours to 1·125 amperes!

The voltage maintained very nearly the value of 1·06 for 2 hours. In 4 hours it had dropped to 0·72, in 5 hours to 0·57, in 10 hours to 0·17, and in 12 hours to 0·14 volt!

The initial value of the watts was 16·8. From that value

the rate of working fell in 2 hours to 14·2 watts, in 4 hours to 6·48, and in 5 hours to 2·51 watts!

But why did Dr. Peddie alter the resistance even "for a few seconds at a time" to measure the voltage and internal resistance? Having ascertained the free potential of the cell on open circuit, there was no need to change anything when once the circuit of the galvanometer and battery was closed. We assume that his galvanometer readings gave him the current strength, and therefore regard it simply as an amperemeter, so by merely noting the E.M.F. between the battery terminals from time to time and the current he could have calculated the internal resistance of the cell—that of the galvanometer being already known and constant—without disturbing any part of the circuit throughout the 12 hours' run. What is required to be known, is the electrical energy in the external circuit; what one loses inside the cell has to be philosophically borne, all a customer wishes to ascertain is, what he can get outside as available power.

The discrepancies, too, between Dr. Peddie's letter to Mr. Urquhart, dated September 23rd, and the report dated September 28th, from which we have quoted, form excellent subject matter for an explanation. It would appear that the coating of the carbonaceous material with copper which takes place in the battery is not conducive to a continuance of either the initial current or the voltage of a newly made up cell. At least this is one explanation which can be placed upon the differences to which we have deemed it worth while to draw attention.

Now, with regard to the comparison of this cell with a Daniell, Dr. Peddie's results differ widely from those of Mr. Tatlock. The former states that while its voltage is practically identical with that of a Daniell, a current strength five times greater can be maintained than that given by an ordinary Daniell *of the same size*. How did Mr. Tatlock manage to get a current 30 times as great, for Dr. Peddie, by charging a McDonald cell as a Daniell, obtained a current of $\frac{1}{3}$ ampere; and, when the McDonald wire spiral was replaced by a copper plate of the size generally used in Daniell elements, of 2·7 amperes?

We leave our readers to give their own explanations of these discrepancies, although that porous pot in the Daniell appears to have much to answer for, and pass on to a statement from a report by Mr. W. A. Bryson, of Glasgow, which reads as if he were somewhat behind the times in accumulator efficiencies.

Mr. Bryson's report, we may add, seems to have been made upon documents sent to him, including Dr. Peddie's figures, and not, so far as we can see, from any actual tests of his own. Quoting this gentleman: "another point in its favour is its light weight—a cell fully filled with chemicals weighs only 8 lbs. Four of these properly coupled up will take up the same room and give the same output as an accumulater cell weighing 65 lbs." Now this is a grave and serious assertion, and we will proceed to see how far Mr. Bryson is justified in making it.

A glance at the list of Faure-King accumulators, specially designed for auto-cars and similar purposes, shows that the 61 lb. cell gives a constant discharge of 53 amperes for five hours with a drop in E.M.F. of only 10 per cent.

If we take four McDonald cells and connect them up so as to give 2 volts and double the current of one, we get, basing our figures on the results obtained by Dr. Peddie, $15{\cdot}84 \times 2 = 31{\cdot}68$ amperes, but in five hours the current in the McDonald cell fell to less than one-third of its initial value, and the voltage dropped to half! Let us now look into the question of watt-hours per lb. of cell. Dr. Peddie gives the *average* current of the cell he tested as being 11·1 at the end of five hours, and the *average* voltage over the same period of time as 0·904. This gives us 50 watt-hours or approximately 6·2 watt-hours per lb. But the new Epstein traction cells give 10 watt-hours per total weight of battery, *i.e.*, nearly double!

How, in the name of everything that is wonderful, can Mr. Bryson maintain the statement with which he is credited above? We shall be greatly interested in hearing his explanation! Both Mr. Bryson and Dr. Peddie should be aware that in accumulator operations it is not the practice to go on discharging after the voltage has fallen from, say, 2 to 1·8 volts, and Dr. Peddie probably also knows that if he had kept the current obtained at the beginning of his test constant for five hours by varying the resistance, the E.M.F. would have dropped still more rapidly!

It is, indeed, strange that a Glasgow consulting engineer should be found labouring under the impression that a cell which, for all practical power purposes, is played out in less than four hours, is of the greatest value to those who require a means of driving auto-cars, unless he would argue that a man could stow away twice as many cells as he actually wants, and that when his electrical energy had run down to half, there would still be as much left as would meet his needs. As science it may be magnificent, but it is not business.

Then Mr. Bryson goes on:—"The storage cell must be recharged at some source of electrical energy, such as an engine and a dynamo. The McDonald cell only requires the addition of some common salt and a *few* (!) crystals of copper sulphate to bring it up to working condition. This simplicity of recharging, combined with its small weight and freedom from noxious fumes, must of necessity render it of the greatest value to those who require a means of driving *auto-cars*, *yachts*, launches, &c."

How often does Mr. Bryson intend to renew the zincs when the cells are employed, say for auto-car driving, and use up some 20 to 30 horse-power-hours of electrical energy? The zinc, apparently, is of no moment!

Mr. McLachlan has already repudiated the large holding of electrically-propelled launches with which he has been credited, and there is only one other point to which we need draw attention, so far as he is concerned.

Mr. McLachlan tested (!) a cell 12 inches high and 4 inches square weighing 10 lbs. He says: "I have taken one of these cells and connected it on direct short-circuit with the ammeter, and it has registered fully 18 amperes at an E.M.F. of 1 volt, sustaining this current for over five hours continuously, and then very gradually falling to zero." When we refer to Dr. Peddie's tests, and find that in four hours the current strength fell to half its initial value, and when we add that Mr. McLachlan personally informed us that his voltmeter was an instrument, such as is used for indicating the voltage of accumulator cells, the accuracy of his readings, and the delicacy of his methods, are both open to grave doubts.

Mr. Wm. J. Dawson, the gentleman who tested the initial voltage of McDonald's cell, but not the final, thus gives testimony under date of September 28th, 1896:—"As to waste of zinc, my experience is that the waste in the McDonald cell is only 2·25 ounces for 100 watt-hours, with zinc protected, but not nursed. This shows a very favourable comparison with other primary cells." Does it, indeed!

Mr. Dawson's experience is too limited. The formula for primary batteries for quantity of zinc consumed in each cell per horse-power hour is $\frac{1{\cdot}995}{E}$ lbs., where E is the electromotive force of the whole battery. Taking E as 1 volt, then even theoretically, approximately 2 lbs. of zinc is necessary to develop a horse-power-hour; practically it is considerably more, and yet according to Mr. Dawson's very extraordinary figures, only $16\frac{1}{2}$ ounces are required! Then, unfortunately, there is Mr. Dawson's previous statement of June 26th:—"Local action, when on open circuit, was one of the great faults of your cell, but of late I have nearly got that put to rights; some further alteration may still further improve matters in that direction."

Altogether we fear that the zinc consumed per 100 watt-hours will figure out at considerably more than double 2·25 ounces, and the cost per horse-power-hour for zinc alone will run into a price above that for which electricity can now be supplied from central stations for motive power purposes.

In conclusion, we need scarcely say that this pamphlet, from which we have quoted, more than confirms the opinions we expressed on the McDonald battery nearly two years ago, and it is the most chimerical of ideas to suppose that these elements have the faintest chance of being employed for work of such a nature as driving auto-cars or anything else which requires a heavy current with practically constant voltage for a few hours at a time, and "one of the inventions of the century," and the "inventive genius" which produced it must be relegated to the category of the commonplace, with possibly a field for the former in telegraphs, telephones, railway signalling, and generally for the purposes to which primary batteries have hitherto been put.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR SPECIAL CORRESPONDENT AT SYDNEY.]

The unfortunate City of Sydney Electric Lighting Bill has again had an obstacle placed in its way, as, although it has just passed through the final stages in the Legislative Council and been returned to the Assembly, its value has been destroyed by an absurd, but vital amendment, which entirely precludes the supply of current for power purposes, and limits the supply for lighting to the hours of darkness only. However, a vigorous protest has been raised by those interested, and it is confidently expected that this transparent attempt to throttle the enterprise will be defeated. Curiously enough a report has recently been submitted to the Sydney City Council by their surveyor on the efficacy and economy of the incandescent gas burner, and recommending its adoption throughout for street lighting.

At Moree, an inland township chiefly noted for its artesian bore, which delivers 3,000,000 gallons per day at a pressure of 96 lbs, the town authorities feel that now that they have railway communication they must also keep up with the times as regards lighting, and are consequently calling for tenders for electric plant for the purpose. A year or two ago the power available from the artesian bore was proposed to be utilised for this enterprise, but does not seem to have eventuated in any practical scheme.

At Albury (N.S.W.), on the borders of Victoria at an agricultural show held recently, Messrs. A. U. Alcock & Co. exhibited a portable electric lighting plant, which so won the hearts of the dwellers in the township, that they requested Mr. Alcock to report to them on the cost of erecting a central electric light station, so that they might have their streets and homes illuminated according to modern methods. Unfortunately, when it was realised what was the amount required to pay the piper the enthusiasm failed, and the whole question was postponed for a time.

Some time ago the Municipal Council of Richmond, situated some 38 miles from Sydney, wrote to the Sydney City Council suggesting the advisability of lighting the city and intermediate places with electric light, the electricity to be generated by means of the waters of the Grose River. The Richmond Council have invited the city councillors to visit the spot and discuss the scheme, which they consider likely to prove of vast benefit to Sydney and all the towns between the city and Richmond. The Water Rights Purchase Association attempted some five or six years ago to obtain parliamentary sanction for the use of the Grose River for a similar purpose, but the whole affair eventually fizzled out; though it is not unlikely that before long this water power will be utilised, but not for transmission to Sydney.

Private enterprise in electric lighting in Sydney appears at present to be confined to the lighting of sundry of the ferry boats plying in Port Jackson. There are some eight or nine at present lit, and contracts have recently been let for the equipment of an equal number belonging to various companies.

In New Zealand a bill has been brought before Parliament by the Premier, making it obligatory for local authorities to obtain the consent of the Governor-in-Council to any proposed concession for the use of electricity as a motive power. From the passing of the Act any right granted for generating or using electricity for power purposes without such authority will be null and void.

Mr. John Hesketh, the recently appointed Queensland Government Electrician, has furnished the local council of Ipswich (Q.) with a long report on the subject of electric lighting for the town. Consideration of the matter has been postponed for the present. On Mr. Hesketh's recommendation the Queensland Government have decided to completely reorganise the telephone system of Brisbane. A metallic circuit is to be substituted for the present earth return circuit; telegraph poles and overhead wires are to be abolished, and an underground pipe system substituted. The cost of the alterations is estimated at £20,000.

The Norseman (W A.) Municipal Council in accepting Dr. Harvey's offer to light the township, give him a monopoly for 30 years conditionally on the plant to cost not less than £5,000, being erected within 12 months, £100 being deposited to ensure the due fulfilment of the contract.

The Hobart and North Western Mineral Fields of Tasmania Railway Company was registered on September 10th, with several substantial names as contributors. Its objects are to acquire from private parties plans of survey, reports, and a draft Bill now before the Tasmanian legislature in reference to a proposed railway from Hobart to the north-western mineral fields of Tasmania; to construct and work the said railway and extensions of the same; and to take water from Lake Augusta and other sources for the production of electricity for working the same, &c.

The demand for connection to the electric supply station of Launceston is so great that already additions are contemplated, and the Launceston Corporation invited tenders locally for a loan of £15,000 for electric light purposes. On September 21st, when the tenders were opened, it was found that less than £11,000 had been applied for, about £6,000 at 2½ per cent. premium and the balance at par. Messrs. Siemens Bros. the contractors for the electric supply station have issued a handsome illustrated pamphlet, descriptive of the station and of the various details of its construction. Active preparations are being made for the holding of an Engineering and Electrical Exhibition in Sydney next year under the auspices and direction of the Engineering Association and Electric Club of N.S.W. The use of the Exhibition Building for three months, free of charge, has already been granted, and the preliminaries are well in train. Similar exhibitions have been held on two former occasions with decidedly successful financial results, and it is confidently expected, in view of the great development of the electrical industry since the last was held, that the forthcoming enterprise will show still better results, especially in view of the impetus given by the passing of the City of Sydney Electric Lighting Bill and the Act authorising the construction of the George Street electric tramway.

SEEING THE HEART BEAT.

The Detroit *Free Press* recently published a despatch on this interesting subject as follows:—

"A most extraordinary series of experiments were tried last evening and to-night at the physical laboratory of the University of Michigan, under the direction of Prof. H. S. Carhart, assisted by Dean V. C. Vaughn, of the medical department, and Drs. W. J. Herdman and F. G. Novy. By means of skilfully contrived apparatus these gentlemen and a few invited guests were able to see the heart pulsations of a living man and watch the play of the bones in various parts of the body when in motion. It was a marvellous sight, and one that inspired the less scientific beholders with profound awe. When the guests entered the room in which the experiments were to be tried there was nothing in sight but a lot of familiar electrical apparatus. A new induction coil stood on a table. Four cells of a storage battery stood under the table. A resistance coil stood alongside. A few scraps of insulated wire, a pair of Crookes tubes and a curious looking box completed the equipment. It was soon explained that this box was the important element in the experiment. The spectator was to glue his eyes to the opening at the small end and look hard at the black pasteboard in front of him. The room was then darkened and the battery turned on, a new Crookes tube of great power being put in the circuit. As soon as the box was turned toward the tube the inky darkness of the interior of the box disappeared and the black pasteboard became grayish-white, like a pane of ground glass. Prof. Carhart then thrust his hand between the tube, now brilliant with the peculiar greenish phosphorescent light that accompanies the production of the X rays, and every bone became distinctly visible on the pasteboard screen, surrounded by a cloudy outline showing the limits of the fleshy covering. The X-ray photograph is shadowy, vague, and unsatisfactory, compared to the results obtained in this new manner. The thinnest gauze more obscures an object to the eye in sunlight than did the covering of skin and muscle obscure the bones in Prof. Carhart's hand. Then his wrist was put in, and his arm to the shoulder. The wrist was turned, the elbow flexed and straightened, and the arm twisted back and forth. It was like watching a skeleton in a slight haze, mysteriously endowed with the power of self-motion. The clothing was no hindrance to the vision, the rays passing through clothing as readily as the naked flesh. Then Dr. Novy tried a few objects in the field, and finally sat before the tube and allowed the spectators to count his ribs, and suddenly it was discovered that the heart was visible, and that its pulsations could be watched and counted. The heart was misty in outline, not distinct like the bones; but there it was, moving regularly, and the spectator counted its pulsations while Dr. Herdman stood with his finger on Dr. Novy's pulse to verify the count, and make sure it was not the flickering of the light that misled the eye. The inside of the screen to the curious box was covered with a layer of tungstate of calcium, by means of which layer the X rays were transferred into rays of light that affect the eye, thus making the X ray visible. An effort will be made after a while to fix a large screen in a doorway, so that all of an audience in a dark room can see the pictures simultaneously, the room supplanting the box. In this way the whole skeleton of a man may perhaps be shwn at once, and at the same time walking about."

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

THE TELEPHONE TRUNK LINE SYSTEM IN GREAT BRITAIN. By J. GAVEY, member. (Paper read November 12th, 1896.)

(*Continued from page* 683.)

1. *Capacity of Sections.*—In dealing with this branch of the subject, requirements of very wide diversity had to be provided for, ranging from cases of offices with a single trunk circuit only to those with 200 or more circuits. Again, the growth of the system, which in certain localities will unquestionably be rapid, had to be considered, and it was obviously desirable to adopt arrangements of such a character, that even in the case of abnormal increase there would be no necessity for any material modification of the apparatus already joined up. To meet these requirements, it was determined to adopt as a unit a section complete in itself, containing all the necessary jacks, cords, indicators, keys, &c., for a certain number of trunks, and to provide as many of these sections as were needed at each office. Each such section is of such a size as to provide space and work for one operator in busy times, although in slack periods the whole of the apparatus on three sections is within the reach of, and can be worked by, a single individual. Thus, an office with one or two trunk circuits is fitted with one section, and briefly, as many sections as are necessary to provide for the existing number of trunks and for a reasonable growth are fitted up to start with. Subsequent growth is met by the addition of the requisite number of sections, without serious modifications of the existing ones; a mere redistribution of

the position of the circuits to facilitate the traffic, together with the undermentioned slight alterations in the case of minor offices, being all that is necessary.

Although switch sections of uniform size and pattern have been adopted, the requirements at the smaller offices are, of course, not exactly of the same character as at the larger ones, therefore three types have been provided, respectively known as "A," "B," and "C" sections.

Small offices with less than three trunks are provided with an "A" section; offices with from three to 10 trunks are fitted with "B" sections; offices with more than 10 trunks with "C" sections.

These sections differ only in the minor details of the arrangement of junction circuits, the presence or absence of transfer circuits, referred to later on, and other small points. The principle of working is the same throughout, and if the ultimate growth of the system at an office renders it desirable to substitute a "B" for an "A," or a "C" for a "B" section, the removal of the existing section is not necessary; but the conversion can be readily effected *in situ*, by withdrawing certain movable ebonite slip holders, fitted with one class of apparatus, and substituting others.

2. The number of trunk circuits on each section is practically determined by the manipulating capacity of an average trunk operator. If the latter be unduly burdened with work, delays arise in establishing communication, the idle periods on each trunk during busy hours become serious, more circuits are necessary for the transaction of business than would otherwise be required, and, as a consequence, there is a waste of capital and of maintenance charges. On the other hand, if the trunks are over-staffed, loss arises in clerical wages. The latter is, perhaps, the less serious item of the two, more especially when long and costly trunk circuits are in question.

As the result of the general experience of telephonic working in this country, and after careful consideration of the whole question, it was concluded that, as an average, a fairly skilled operator should work five trunk circuits with facility and without delay. Accordingly the unit section was designed to accommodate this number.

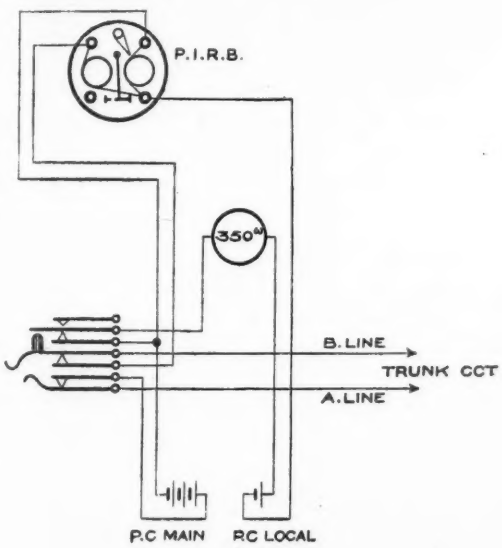


Fig. 11.

3. *Signalling, &c.*—In the very earliest days of telephone exchange working, Mr. Preece introduced an automatic system of signalling, which was so designed that the mere act of removing a telephone from its support announced a call by the dropping of a shutter in the exchange, whilst the restoration of the telephone to its normal position caused a current to be sent to the exchange which indicated, by a visible signal, the completion of the conversation, and the necessity for withdrawing the connecting pegs and restoring the shutter. This system became general in all Post Office exchanges, both on local and in a modified form, on trunk circuits.

In ordinary methods of open-circuit trunk working the switch operator first inserts a peg in the trunk jack, then rings up her correspondent by means of a separate key or press button. The reverse operations are repeated at the close of the transactions, and if several trunks are connected at intermediate points, these operations have to be repeated on each trunk.

With an automatic system of signalling the insertion of the peg indicates a call at the distant office, and its withdrawal indicates the close of the transaction. These signals are automatically repeated through any number of independent trunks which for the time being may be joined up to form one circuit.

The conventional signals which have been adopted by the Department are the following:—

Indicator needle to the right ...	Line disengaged.
" " " left ...	... Calling.
" " vertical ...	... Line engaged.

The line indicator is a combination of a polarised relay, the electro-magnets of which are placed horizontally, with an indicator needle in front of the poles.

Normally, when the switch is fully manned, the traffic is regulated by the movements of the indicator needle alone, but for slack periods and at night the relay is brought into use to repeat calling signals through a local circuit by means of a bell or a buzzer. These bells are cut out of circuit by suitable switches during the day. The manner in which the signals are transmitted is illustrated in fig. 11.

It will be observed that in its idle position the line terminates on the indicator relay, in circuit with which is a battery of six cells known as the "permanent current line battery." A second battery of three cells, known as a "permanent current local," is joined up through a 350-ohm resistance and through the right-hand half of the relay electro-magnet in such a manner as under certain conditions to reverse the polarity established by the line battery.

The distant end of the line being terminated in a similar manner, the two positive poles of the respective line batteries are normally connected to the "A" line, and the two negative poles through relays to the "B" line; thus, if the insulation is reasonably high, no current flows from either end, and these batteries have no effect on the relay indicators. On the other hand, the local permanent current batteries send currents through the right-hand half of each relay electro-magnet, the effect being to deflect each indicator needle to the right.

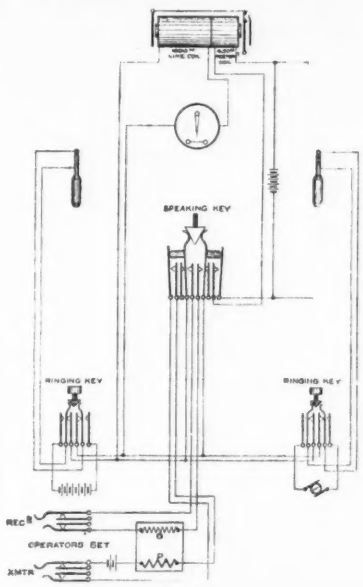


Fig. 12.

If the distant operator now inserts a peg, she disconnects her indicator relay with its opposing batteries, and substitutes the resistance of her local apparatus alone. The permanent line battery current at the near end then flows with a reduced electromotive force due to the effect of the local battery, but in the opposite direction to the local current through the right-hand coil, and with the added electromotive force of the local battery through the left-hand coil of the relay. The polarity of the electro-magnet is reversed, and the needle deflected to the left.

On the insertion of a peg in the home jack to respond to the call, that indicator is also cut out of the line circuit, the local and line signalling batteries are disconnected, and the indicator needle becomes vertical.

Ringing keys are likewise provided; one set, with black press buttons, being connected to batteries; the second set, with red press buttons, being joined to a small alternating dynamo, a pole changer, or a magneto ringer, according to the size of the office. The connections are illustrated in fig. 12.

The black keys are used for ringing up subscribers to Post Office exchanges, and for occasional use on the very long trunk circuits; the red keys for calling up the National Company's exchanges and subscribers.

Separate indicators are provided in the switch cords to announce the completion of the conversation or the "ring off." There are two of these joined in series and bridged across each pair of cords, which form an electro-magnetic shunt with a resistance of 2,000 ohms. Owing to the self-induction of these shunts, they act as choking coils to the rapid vibrations of the microphone, whilst responding readily to permanent currents or slow alternations. One of the indicators is a simple form of galvanometer designed to repeat the automatic signals in use on the Department system, the second a Western Electric self-restoring indicator to respond to the magneto "ring off" of the company's subscribers.

When a Post Office subscriber is using a trunk circuit, and on the completion of his conversation, the restoration of the telephones to their supports sends a permanent current to the exchange. This deflects the galvanometer needle described above; the exchange operators at both ends withdraw the pegs; and, if only one trunk circuit is in use, the indicator relays, which are now brought into circuit, are both deflected to the right. If several minor trunks have been joined through at various intermediate points, the line permanent currents from the terminal offices deflect the needles of the telephone galvanometers at the intermediate points where connections have been effected. The operators, without further inquiry, withdraw the pegs, and the normal condition of things is restored.

When a trunk is in use by a subscriber to the National Telephone Company, the operators are dependent on the business-like aptitude, or otherwise, of the subscribers for the "ring off." Should the latter fail to give the requisite turn of the handle to his magneto ringer, the Post Office operators have to come into circuit at the expiration of the allotted period to inquire if the conversation is finished before withdrawing the pegs.

Should a prompt reply not be given to an automatic call on a trunk circuit, the black keys can be brought into use to obtain attention.

Fig. 13 illustrates the connections on an "A" or "B" section.

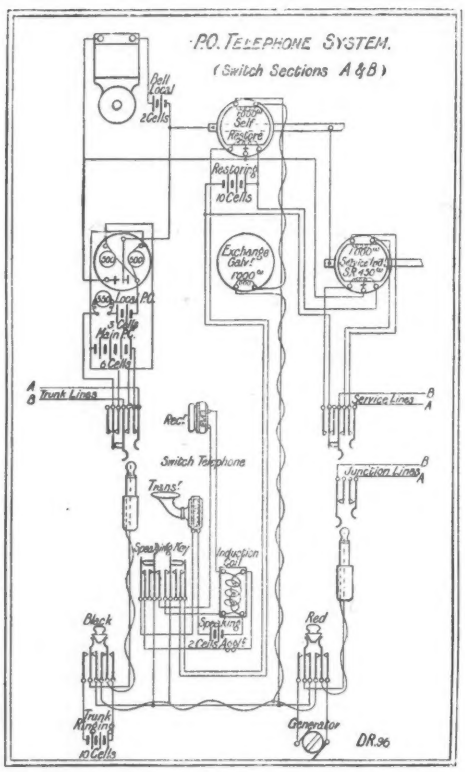


FIG. 13.

4. Communication between different sections in one office to admit of joining one trunk circuit through to another can be effected in several ways. The most simple method of dealing with the problem consists in providing direct junction wires between each section and all the others; and this plan has been adopted where the sections are four or less in number, or where through trunking will, from the nature of the traffic, be infrequent. At large offices, however, the number of junctions necessary for this system would be very considerable; and, as in practice it would be necessary to limit this number, then each junction would have to be multiplied along all the sections. To work these would involve the following operations:—

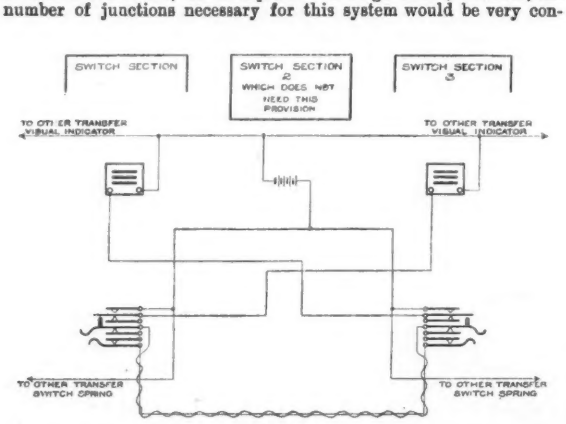

SWITCH SECTION
SWITCH SECTION 2
WHICH DOES NOT NEED THIS PROVISION
SWITCH SECTION 3
TO OTHER TRANSFER VISUAL INDICATOR
TO OTHER TRANSFER VISUAL INDICATOR
TO OTHER TRANSFER SWITCH SPRING
TO OTHER TRANSFER SWITCH SPRING

FIG. 14.

First—Testing for the engaged signal;

Secondly—Ringing up the section wanted;

Thirdly—On receipt of reply, transmitting the demand; these operations in practice involving more or less delay.

To overcome these difficulties, a modification of the divided board arrangement was introduced, which is, briefly, as follows:—

A through trunking or transfer section, sufficient to meet the requirements of 50 trunks, is provided for each 10 ordinary sections. From each section three "down" junction wires bearing the number of the section, and lettered A^1, A^2, A^3, are carried to the transfer section, where they terminate in cords and pegs. Similarly, two "up" junctions, terminated on jacks numbered and lettered B^1, B^2, start from the transfer section to the respective switches, where they terminate in jacks. The transfer switch is fitted with a three-position key for each "A" junction:—

1st position	...	...	...	Normal;
2nd position	...	...	...	Speaking;
3rd position	...	...	...	Through;

and both these and the jacks are provided with contacts which actuate small grid indicators, which have in practice received the somewhat inappropriate name of "visual indicators" through local circuits.

The method of working is, briefly, as follows:—Glasgow requires communication with Cardiff, which at present would be obtained through Leeds. Glasgow calls Leeds, obtaining attention on, say, section 3, whilst the Cardiff trunk is, say, on section 14. The Leeds operator on section 3, on hearing the requirement, simply pegs Glasgow trunk through a disengaged "A" junction to the transfer switch, and this operation actuates a visual indicator on the junction at the latter point. The operator at the transfer switch then turns the key to "Speaking," and ascertains from Glasgow what is required, whilst the act of turning the key to "Speaking" drops a visual at section 3, which intimates to the operator at that section that the requirement is having attention. The transfer operator, on hearing that Cardiff trunk is wanted, pegs the "A" junction from section 3 into a "B" junction to section 14, thereby dropping a visual at the latter. The operator at this section, in pegging in a cord to reply, drops a visual at the transfer section corresponding to the "B" junction brought into use, which shows that the call is being attended to at the section on which the Cardiff trunks are terminated. The operator in charge of the latter then completes the connection.

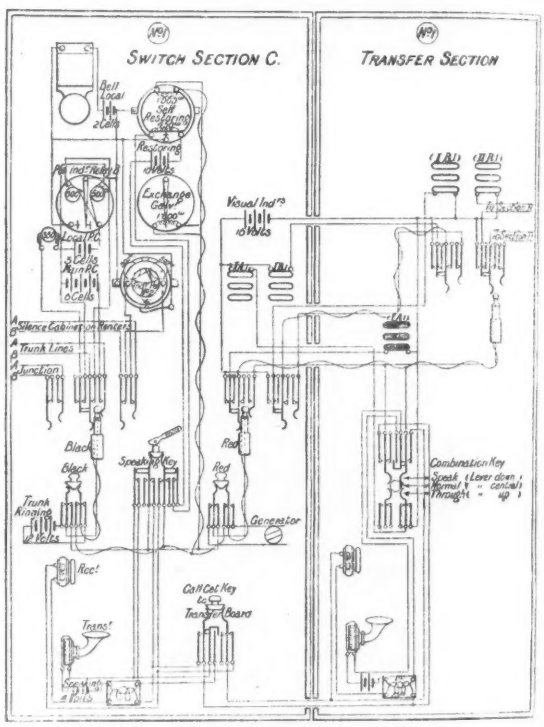


FIG. 15.

The talking is thus reduced to a minimum, being limited to two repetitions of the request for the Cardiff trunk, the automatic signals in all cases intimating to the operator who has pegged a trunk or a junction through that the next individual is attending to the call. None of these visuals are in the line circuit, but they are joined up on local circuits, and they remain depressed as long as the trunks are through. When the conversation is complete, this is indicated at sections 3 and 14 by the automatic signals from Glasgow and Cardiff respectively. The operators at these sections by withdrawing the pegs release the visuals at the transfer. The transfer operator on observing this withdraws the connecting peg and restores the speaking key to "Normal," which also releases the visual of switches 3 and 14.

The connections for direct junctions connecting limited number of sections in small offices are shown in fig. 14, while fig. 15 illustrates the transfer board working.

5. The general details have been partially illustrated by the preceding figures. Actual switch and transfer sections have been joined up in this room, and can be inspected at the close of the meeting.

The system of duplex working that has been used by the National Telephone Company for some time has been adopted by the Department. Fig. 16 gives a diagrammatic sketch of the method of joining up. In this it will be observed that differential transformers are used, the secondaries being accurately balanced both for resistance

and self-induction before they leave the workshop. No variable resistances are inserted, as any attempt to adjust in order to compensate for variations in the line would probably be a perfectly hopeless task. Under these conditions circuits of moderate length work satisfactorily, no ordinary changes in insulation resistance causing an upset of the duplex working so long as each of the arms is in sufficiently good order to work efficiently as a simple circuit. It is found, however, that if the circuits exceed a certain length, it is difficult to maintain satisfactory duplex working; so that, for the present, this method is not applied to any exceeding 50 miles in length.

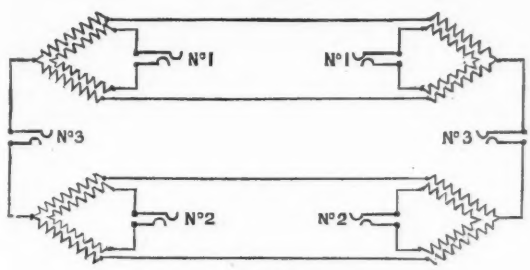


Fig. 16.

In the preceding remarks an endeavour has been made to describe succinctly the system of working adopted by the Post Office for its trunk lines. Of course these arrangements are not final, and already modifications are under consideration, which have in view the facilitating of the switching operations by the further substitution of automatic signalling for verbal instructions on the junctions connecting the National Company's exchanges with the post offices. The growth of the system itself is progressing by leaps and bounds, and although trunk telephony is but of modern growth, and has in the past served rather as an adjunct to the ordinary methods of telegraphing, the time is rapidly approaching when it will rival the older methods in the extent of the plant, and in the importance, if not in the number, of daily transactions.

Discussion.—November 13th.

The President, in moving a hearty vote of thanks to Mr. Gavey for his most valuable and interesting paper, said that it was just the sort of paper they wanted at the Institution. It was essentially of a practical and useful character, and contained information which it was impossible for them to obtain except when brought before them in that way.

Mr. Dane Sinclair said he could open his remarks better if he were able to quarrel with the paper more. The fact was that the paper, from the beginning to the end, was of such a nature that the only remark he could make was that he wished he had been able to write it himself. There was, however, one feature that must be intensely interesting to those members of the Institution who were not telephone men; that was, the theoretical principle in the first part of the paper. So far as his experience went, he was in exact accord with the words and with the ideas that Mr. Gavey had expressed. Induction on the line had been ascribed to a hail storm at the other end, but the leaders of science had enabled them to see the facts as they absolutely exist. In his closing remarks Mr. Gavey described the use of the call wire between the company's exchanges and the post offices generally. He (Mr. Sinclair) was going to add that now they were beginning to find it an improvement to make more use of signals and less of the talking. With regard to duplexing telephone lines, he thought it was not too much to say that they had done more in this country than in most foreign countries. From a practical point of view, they had done more than any other country. So far as he knew, before the transfer there were many miles of duplex—he forgot the actual mileage of wire—60 or 70 duplex circuits averaging 30 or 40 miles long, he thought. The subject was of immense importance in regard to cost if equally good working could be obtained. He hoped that some of their friends would find something more to say. He could now only compliment Mr. Gavey on his paper, and compliment the Department on the exceeding care which they had taken. He was the last week in Sweden examining into the working of some of their lines, but while they had much that was very excellent, he was sure that if the gentlemen he met there were at the Institution that night, and saw the arrangements provided there, they would find it very difficult to improve on them in any way.

The Société Internationale des Electriciens.

The meetings of the Société Internationale des Electriciens have just commenced. The November meeting took place on the 4th, at the Hall of the Société d'Encouragement, M. G. Sciama acting as President, assisted by MM. Pellat and Sartiaux, vice-presidents. M. Hillairet, general secretary, who had been sent as delegate to the Geneva Congress, gave an account of the work done at the Congress, the excursions that were arranged, and asked for a vote of thanks for M. Palaz, M. Turettini, and the Swiss Association of Electricians, for their kind hospitality. This met with unanimous assent.

M. Perrin then explained the mechanism of the discharge by the Röntgen rays of electrified bodies. The explanations are quite theoretical, and can be summed up in the following manner:—For an electrified body to be discharged, the rays must meet the lines of force emanating from the body. A tube of force cut by the Röntgen rays, and situated in gas, acts as a conductor. These rays can then charge an isolated body, which is placed in an electric field. The tubes of force that are cut seem only to become conductors in a gaseous medium. Mr. Perrin performed some experiments in charging and discharging, which were illustrated on the board to confirm his explanations.

M. Paul Janet then read a paper on the Temperature of the Filaments of Incandescence Lamps.

Up to the present, only three values have been determined. In 1886, M. Garbe found 2,250°; in 1891, M. Weber found 1,300°; and in 1892, M. Lechâtelier found 1,800°. M. Garbe applied M. Crova's optical method, which consists in determining the *optical temperature*, *i.e.*, the temperature for known radiations comprised between 0 μ, 676, and 0 μ 523. We then deduce therefrom the temperature of the lamp. M. Lechâtelier compared the red radiations of a source to be studied with a standard source, with the aid of a Cornu photometer, which he had graduated by a thermo-electric couple, in order to know the temperatures corresponding to the luminous intensities. M. Weber, of Zurich, established a formula based on the radiation which gives the total quantity of heat disengaged per second as a function of the temperature. This formula, reduced to its simplest expression, is as follows:—

$$Q = CS\tau e^{a\tau}$$

Q is the quantity of heat disengaged.

C is a constant characteristic of the body employed, and which, for carbon, is equal to ·000013.

S is the incandescent surface.

τ is the absolute temperature of the source.

a is a constant, which is the same for all bodies, and equal to ·0043.

Previous experiments at known temperatures enable a to be determined.

M. Janet's new method consists in determining the power expended in a lamp as a function of its resistance. The resistance being itself a function of the temperature, we can thus know the power expended, and consequently the heat radiated at a given temperature. We then trace the curve of the cooling of a lamp as a function of the time by suddenly breaking the circuit which feeds it, and measuring all the successive values of the resistance. We can thus know the total quantity of heat lost by the filament during its cooling. By using M. Violle's formula, which gives the total quantity of heat to be supplied to 1 gramme of carbon, in order to bring it to a given temperature, we can easily determine this temperature. M. Janet explains that these measurements of variations of resistance are effected by placing the lamp in the arm of a Wheatstone bridge. Precautions ought to be taken for measuring the variations of resistance during the cooling. The method is now being tried, but no measurement has yet been made.

At the end of the meeting, M. Pellat briefly explained the mode of graduation of the Deprez D'Arsonval galvanometer.

CORRESPONDENCE.

Municipal Wiring and Free Wiring.

With reference to the article in your paper of this week, under the heading "Municipal Wiring and Free Wiring," you remark that there is something to be said for, and a great deal against, municipal wiring. Whatever can be said in its favour, I think a very great deal can be said against it. Regarding Liverpool, when the Corporation bought the works from the company, it was thought generally that they would be satisfied with the profit derived from the supply of the current, but it seems they do not intend to be, but compete against local contractors for the wiring and fittings; although when I wrote to one of the local papers upon this matter, their opinion was that they thought the chief profit was derived from this part of the business: is this so? My opinion is rather different. The wiring contractor is, as you say, a great friend to the supply company or electric lighting department, although he is not very often treated as such; and he could still be a greater friend, especially in Liverpool, if the prices for services from mains and fixing meters, &c., were reduced. Very often the high price charged for this portion of the work in this town deters a small consumer from having his place fitted at all, if it be as much, which is very often the case, as what it will cost him for his interior wiring and fittings, and especially if the account for the Corporation's part of the work is presented before their work is started, let alone completed and the current on. As

this is a matter which requires ventilating, as it is as of much importance to the intended consumer as electrical contractors.

E. L. Liley.

Power Tenders for Motor Cars.

In your article on "Motor Cars" in this week's issue, you discuss the proposal to prevent vibration by carrying the oil engine on separate wheels, and conveying its power to the vehicle by electrical means. As I am in a manner involved in this proposal, will you allow me to make one or two supplementary observations? In the first place I think that the storage batteries referred to should be reduced to the lowest possible limit owing to the many difficulties that attend their use; indeed, I should be inclined only to store enough power to start the engine alone, before it is switched on to the carriage motor (so that the engine need not be run during a halt). Secondly, as to the form of the tender; I would have it to consist essentially of a box containing the oil engine and dynamo carried on two wheels, so as to secure lightness. We may further suppose that two shafts project backwards from the rear axle of the vehicle, the outer ends being coupled to the axle of the tender, which may be put in or taken out much like a horse. The oil engine and dynamo should be of a vigorous and high speed type; the vibration would no doubt be tremendous, but would practically not reach the main vehicle, though a seat could easily be provided on the tender for such people as profess to enjoy riding over an oil engine!

Alfred J. Allen.

London Institution,
Finsbury Circus, E.C.
November 23rd, 1896.

The McDonald Battery and its Tests.

I have just returned from Aberdeen, where I have been for a few days.

I have a letter from Mr. McLachlan, mechanical and electrical engineer, who reports as to his meeting with you, and explains that I have been wrong in speaking of him as "possibly the largest owner of electrical launches in the kingdom," that he only owns "one launch, and has in stock several portable electrical propellers." I, of course, have been in error in speaking of Mr. McLachlan thus, and must have confused his name with another. For this I am sorry; but fortunately my mistaken description of the gentleman in question does not affect his opinion of the battery, which is the same *now* as it has ever been. He says, "I assure you I have just as much confidence as ever in the McDonald cell, and time only will prove my statements to be true."

A. Urquhart.,
McDonald Patent Battery Syndicate.

[We thank Mr. Urquhart for his reply to our note in last week's issue, but we fear it is but a sorry explanation. Would it not be well to have that pamphlet thoroughly overhauled, and the battery tested under real working conditions, say, by Prof. A. Jamieson. As to Mr. McLachlan's opinion of the battery, we have yet to learn that this amiable gentleman's views have any value in scientific circles, and he may one day find that his confidence is sadly misplaced.—Eds. Elec. Rev.]

Announcement.

Please kindly let me say for your information, that this company does not propose taking up "installation work." This question is being put by some of our friends, in connection with the absorption by this company of the Manchester Edison Swan Company.

H. Charles Gover,
Secretary, The Edison and Swan United Electric Light Company, Limited.

Electricity in Mines.

Mr. Kennedy, in your issue of November 20th, fails to distinguish between theoretical and practical every day results. What I maintain is that working electrical plants show a higher efficiency than working compressed air plants.

The theoretical results given on pages 240, 241 and 243, of Prof. Unwin's book on "Transmission of Power" (44 to 51 per cent.), and which he says "should be such as are practically realisable in ordinary work," only go to prove that my figures of 30 per cent. to 50 per cent. are not far wrong. This, of course, is leaving reheating out of the question as undesirable.

I do not agree with Mr. Kennedy when he says that reheating is permissible in any mine where a motor with a commutator would be allowed.

As Mr. Kennedy says, it is a question of time proving whether commutatorless motors are better than motors with commutators for fiery mines, but up to the present, in my opinion, they have shown no advantage in safety, as what danger there is lies more in the cables and fittings than in the motors.

Mr. Kennedy is apparently arguing on the theoretical efficiencies in each case, neglecting the actual efficiency obtained in practice, which I hold is nearer the theoretical efficiency in the case of electricity than of compressed air.

I am glad to be able to agree with Mr. Kennedy as to the question of first cost and convenience of electricity.

H. W. Appleby.

Leyton Electric Lighting Works.

In the descriptive article under this heading in your issue of the 20th inst., there is a detailed sketch of part of the governing gear used on the gas engines at Leyton, but the important point as to whether the governing is effected by the "hit and miss" arrangement, or if the charges are graduated or diluted for light loads, is not made clear.

As the light load efficiency of gas engines in particular—or any engine except the steam turbine—is such a serious matter to a small central station with only two units, such as Leyton, it would be interesting if such articles went more fully into the governing arrangements, speed variation, &c., and efficiency on *light load*.

If the graduation system of governing has been employed it seems to work well, judging from the published results—·22d. per unit.

I should also suggest that when novel arrangements and designs are described in such articles, the designer's reasons for such arrangements if given (when not obvious), would make the articles much more interesting and satisfactory to your readers. In this connection, referring to the balancing transformer, it is not clear why the positive fuse is set to blow at 70 amperes, when the negative blows at 75 amperes. If there should be any difference between these fuses (I can't see why there need be), I should say that the positive ought to be the larger, as I gather from the article that this side of the transformer is chiefly run as a motor, and there is a slight advantage in arranging for the generator fuse to blow before that of the motor, for if the latter goes first (which it generally does if the fuses are equal) the sparking at the generator brushes will be rather severe. But at Leyton the centre wire fuse is designed to blow first, so that I cannot trace any reason from the article why the smaller fuses are of unequal capacities.

Then on page 659, when the engines are running, the batteries are connected between the two outer conductors; but when the engines are shut down, the cells are run between the positive and centre, the motor generator taking care of the other side. How and why is this done? Are the two sets of cells run in parallel (if so, what happens when one cell dies), or is only one half of the battery in use at once?

If the switching arrangements for the regulating cells are designed to work on this plan only, then it looks as if the transformer can never be shut down, except when the system is perfectly balanced.

T. R. D. Kenny.

Bradford, *November 24th.*

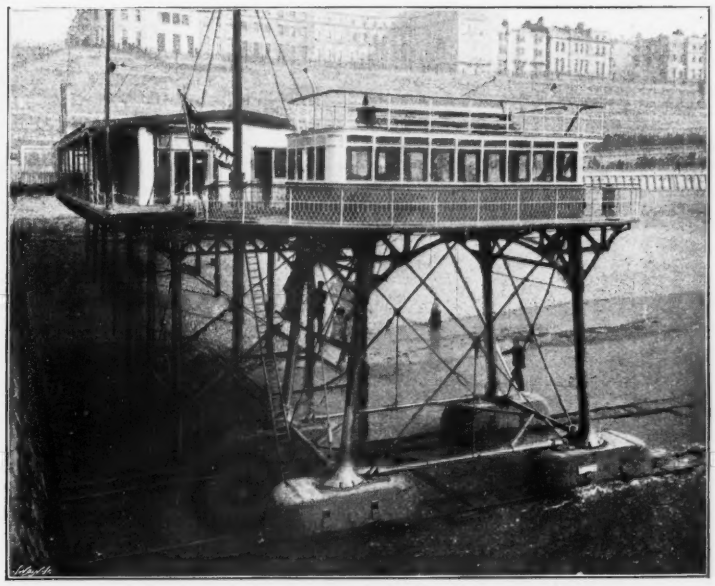
[Our correspondent will see in the Notes columns that an error was made in describing the use of the batteries. The fuses blow at 75 amperes in each case.—Eds. Elec. Rev.]

(*Correspondence continued on page* 705.)

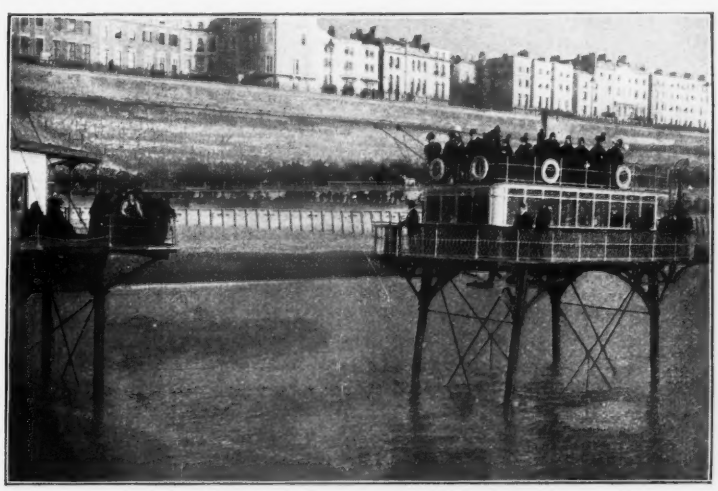
A RAILWAY THROUGH THE SEA.

From time to time the daily papers and others have referred to a novel electric railway which Mr. Magnus Volk was carrying out at Brighton.

The project has now been carried to a successful issue, and some days ago a representative of the Electrical Review had the privilege of inspecting Mr. Volk's curious railway. No doubt many readers of this journal are familiar with a small sea-shore tramway at Brighton, which for some years has been operated by electricity, a centre rail being employed to carry the electric current. Mr. Magnus Volk is the proprietor of this small tramway, and its success led him to seek means of extending it to Rottingdean. The distance of this place from Brighton may be only three miles to a crow, but to an ordinary mortal it is a goodly four. There were difficulties in the way of extending the system as it stood. Owing to the foreshore between Brighton and Rottingdean being for the greater part of 24 hours covered by water, it appeared that the best way of constructing a line would have been to take it over the cliffs. After careful consideration, however, Mr. Volk determined to use the foreshore at a point slightly above low water mark, but some 14 feet below the sea at high water. As it was proposed to run the cars, irrespective of the condition of the tide, it was necessary to provide a vehicle of very special construction. It will be seen from the illustrations that the projectors of the line have succeeded in building a car that is totally unlike any other form of movable structure, not excepting even the ark. The important characteristic of the vehicle is a structure half boat and half car, which is mounted on four long legs, at the end of which are the wheels.



Car at the End of Pier.



Car Leaving Pier.

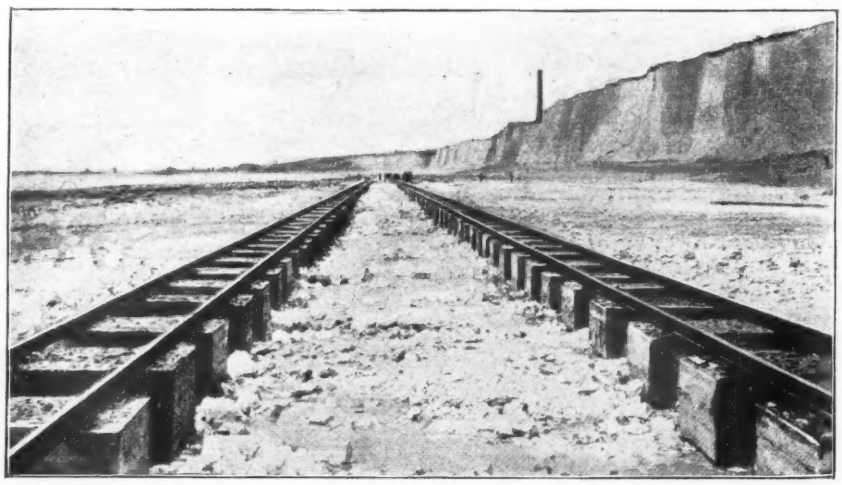
Although the railway which has been just completed at Brighton will have no important bearing on the question of electric traction, still the system presents many ingenious features which are interesting to engineers.

The chief peculiarity of the track is the employment of four rails, and when the tide is down, and the lines uncovered, it has the appearance of double lines of exceedingly narrow gauge. The line consists of four rails of 54 lbs. to the yard, the distance between the two outside rails being 18 feet, which gives an idea of the width of the car. In laying the track there were many difficulties to overcome, the fact that work could only be done when the tide was down, coupled with the possibility of the incoming tide undoing what had been done, gives an indication of the nature of the operations. The rails are securely fastened to concrete blocks placed every few yards, by means of steel clips and bolts, the bolts passing through oak blocks placed between the rails and the concrete. Tie rods are used every 10 feet on the straight and every 5 feet on the curves, heavy angle fish plates being used for the rail joints.

The feature of the system is the car, which is furnished with 16 wheels. Each leg of the car is mounted on a four-wheel bogie, and the wheels of the bogie run on the narrow gauge line. It will be noticed that the bogie trucks are shaped like a double-ended boat, to facilitate passage through the water besides removing obstructions from the lines. The four bogies are firmly held together by steel tubular struts. The wheel base is about 28 feet, and this combined with the effective gauge of 18 feet ought to give sufficient stability. The top of the main legs carry lattice girder work, on which the main deck is erected, the whole structure being braced together by means of cross ties. Before passing on to speak of the means of driving, it will be interesting to refer to the upper part of the structure. The idea of Mr. Volk and his assistants has been apparently to reproduce as far as possible the special features of a pleasure yacht, for the main deck appurtenances, and erections are carried out as one would expect to find them on a model steam yacht. Indeed, they go so far as to carry a small boat and a supply of life buoys. The main deck is about 50 feet in length, and 22 feet in width. There are iron railings round the deck, provided with wire netting. The centre of the deck is taken up by a saloon, which is 25 feet long and 12 feet wide; the interior being furnished and upholstered in a very handsome manner. A second deck has been made on the top of the saloon, and, altogether, the carrying capacity of this car-yacht must be approaching 200. As an easy means of enjoying sea breezes without drawbacks, this railway ought to be unrivalled.

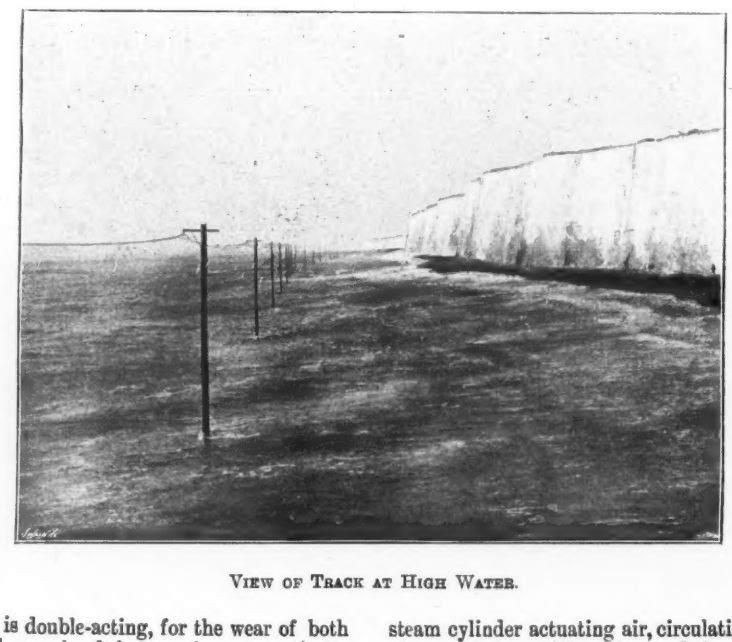
Coming to the means of propelling this structure, it ought to be observed, first of all, that electrical energy is conveyed to the car by means of overhead wires, the necessary collection of current being performed by two trolleys of a special

type, devised by Mr. Philip Dawson. On the car are two 30-H.P. motors of the G.E. 800 type, which have been supplied by the British Thomson-Houston Company. The motors are placed vertically over two of the main legs, the armature being connected through bevel gearing to a vertical shaft, which at the bottom is geared through bevel wheels and single reduction gearing on to the axles of the wheels. A reference to plan and section of the gearing arrangements will make the working clear. The controlling devices which are placed on the main deck are very similar to what one finds on a modern tramcar, a G.E. controller being fixed at each end of the deck; the brakes are operated by rods passing down the two unoccupied legs. The generating machinery is erected at the Rottingdean end of the line, the plant being located on a specially constructed iron pier, which serves also as a landing stage; piers have been, of course, rendered necessary at each end of the line. The plant, consists of a General Electric Company four-pole railway generator direct coupled to a high speed double acting engine made by Messrs. W. Sisson and Co., of Gloucester.



View of Track at Low Water.

The engine is provide with patent automatic shaft governor, and patent self-a justing connecting rods, and has been specially designed for being direct coupled to electric generators for electric railway and tramroad purposes. The partially superposed arrangement of the cylinders allows the centres of cranks to be brought closely together, and thus the moment of the disturbing forces due to high speed is reduced to a minimum; and as the reciprocating weights in the two cylinders are made equal, the balancing of these can be performed with a close degree of approximation.



View of Track at High Water.

The patent self-adjusting connecting rods are claimed to ensure quiet running, although the engine runs at high speed and is double-acting, for the wear of both crank-pin brasses and crosshead brasses is automatically taken up by the appliance, and yet without risk of binding and heating.

The patent crankshaft governor recently designed specially for this class of engine has the working parts reduced to a minimum, the bearing surfaces being very large; the gear is arranged to control both the H.P. and the L.P. valves, which is claimed to secure, with extreme and sudden variation of load, a more prompt and close regulation of speed than can be obtained if only the H.P. valve be under the control of the automatic expansion gear.

The whole of the working parts, excepting the intermediate valve rod and lower end of valve spindle, are enclosed in the crank chamber and lubricated by an oil bath fixed in the lower part of this, while water circulation in the lower chamber or bed is provided to keep the oil cool, and a special arrangement of splash plate is fitted just below the cylinder bottoms, in order to avoid the oil splashing up against these and thus becoming heated. Although the engine is thus enclosed, a very ready access is obtained by means of a large circular opening at the front, which is bored out conically and fitted with a light dished steel door with thickened rim turned conical to fit the recess, and this is secured by means of a central bolt, exactly similar to the door of a locomotive smoke-box.

The engines have cylinders 7½ inches and 13½ inches by 7 inches stroke, and are designed to give a maximum speed of 550 revolutions, developing 110 B.H.P. as a maximum; but it has been found that ample current is developed when the engine is running at 525 revolutions.

The engine is supplied with steam at about 120 lbs. through a reducing valve from a marine return tube boiler, W.P. 150 lbs. The object of this arrangement is to allow for the large fluctuation of work, and to permit the boiler to act as a reservoir by means of increase of pressure, and at the same time a heavy draft of steam occurring through sudden and large increase of load, is less likely to cause priming.

The condensing plant is also of Messrs. Sissons marine type, and consists of a circular condenser shell of galvanised steel, with rolled yellow metal plates and tinned brass tubes, secured by screw glands and cotton packing. The auxiliary pumping engine has a separate steam cylinder actuating air, circulating, and feed pumps, the air pump being single acting, and the circulating pump double acting, and specially arranged to continue drawing as long as the tide gives a supply to the strainer box, which means a lift of about 25 feet. The suction pipe is fitted with a retaining valve, and for convenience in filling the long suction pipe when beginning work, a priming cup and cock are provided. The feed pump is also double acting.

The main engine is fitted with a special arrangement of

automatic exhaust valve, adapted to open freely to the atmosphere in case of unobserved failure of circulating water and consequent loss of vacuum, and in such case the automatic exhaust valve opens and delivers the exhaust into funnel.

In the engine house is a switchboard on which an automatic circuit breaker and the usual measuring instruments are arranged. An electric current of 500 volts pressure is delivered direct into the overhead wire, which is suspended

Car Passing Through a Heavy Swell.

partly on steel and partly on wooden posts. At low tide the return is by the rails, and at high water the sea is used, which calls, however, for no special bonding.

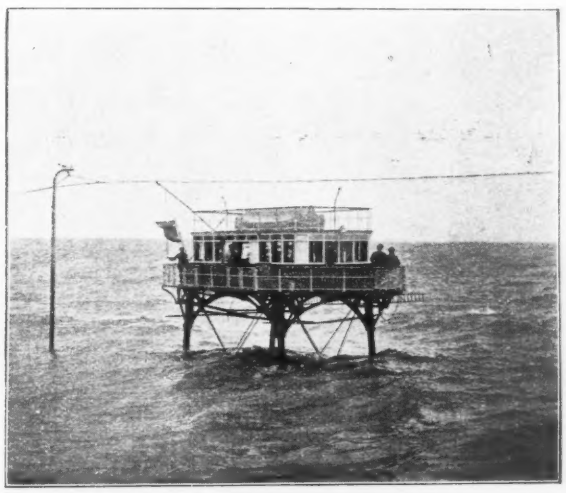
We believe the total cost of the line is about £30,000, this sum, however, including the construction of the two piers.

Mr. St. George Moore has been the consulting engineer to the undertaking.

DIAMOND MAKING BY ELECTRICITY.

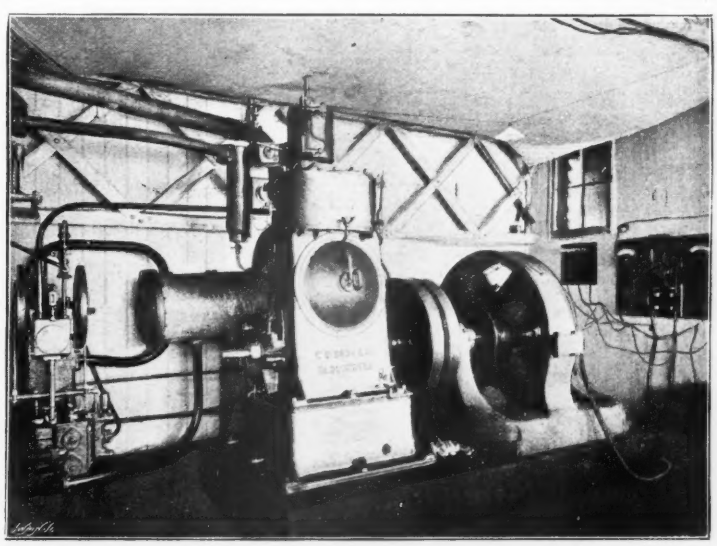
A few weeks ago M. Henri Moissan delivered a lecture on "The Electric Furnace" at the College of Physicians and Surgeons (New York). This lecture was given by invitation of the New York Academy of Sienees, the New York Section of the American Chemical Society, the American Institute of Electrical Engineers, the College of Pharmacy of the City of New York, and the New York Section of the Society of Chemical Industry. The lecture was illustrated by experiments.

The lecturer introduced his subject by pointing out that while the carbon compounds have been studied with great care by organic chemists during the past 50 years, the study of the different stages through which carbon passes had been comparatively neglected. In his endeavours to obtain pure carbon from the ordinary amorphous carbon—lamp-black, containing from 10 to 15 per cent. of impurities, he had found it necessary to use very high temperatures, and had succeeded in obtaining graphite. High temperature alone, however, would not yield the crystallised form of carbon, diamond. He set to work to find out the composition of diamonds by reducing some to ashes. In all, whatever source they came from, he found iron, save in one very pure hard green stone from Brazil. By the study of the nature of the ground, and of the geological formation in which Cape diamonds are found, he found that the earth, besides graphite and microscopic diamonds, always contained granite. Granite is the product of great pressure, and this fact led him to the idea that diamonds might also be obtained by pressure. As cast-iron increases in volume in passing from the liquid to the solid state, he was led to believe that if an element of carbon were enclosed in a globule of cast-iron that was cooling it would be subjected to the requisite pressure.



View of Car from the Shore.

In order to obtain a heat sufficiently great, and at the same time to be able to measure it, he devised a simple form of electric furnace. It consists of two lime or chalk bricks, the lower one about 18 inches square and a foot deep, the upper one about 6 inches deep. In the lower one is hollowed out an elliptical hole to contain the crucible, while two carbon electrodes pass from the cavity to the exterior, where they are connected with the source of current. The upper brick serves for a cover. M. Moissan first sprinkled the cavity with magnesia in order to prevent the formation of calcium carbide. He then placed in it the graphite crucible, into which he had put some soft iron filings and charcoal, covered it with the top brick, and turned on the current.



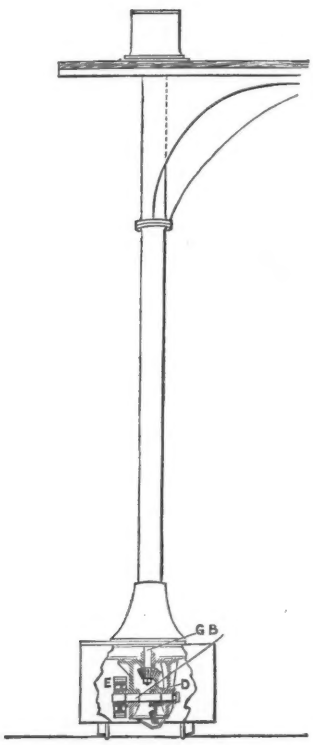
A Railway through the Sea.—View of Generating Plant at Rottingdean.

In three minutes the pyrometer showed a temperature of 2,500° Fahrenheit, and the chalk was boiling and flaming. At the end of 10 minutes the process was complete.

On breaking the crucible he took out an ingot the size of a bullet, and explained the processes by which the iron would have to be eliminated in order to get at the crystallised carbon that was within it. These diamonds have no commercial value, as the largest he has succeeded in making is only 1 millimetre in diameter.

The form of the crystals varies according to the method most used in cooling. When water is used the diamond is often full of black specks, which detract from the value of the stone.

When molten lead is used to cool the crucible, the crystal takes the shape of a small rectangular figure, sometimes with

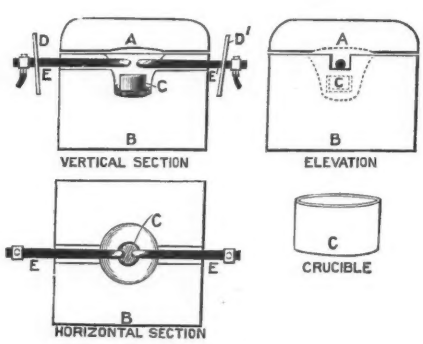


G, B, Gunmetal bushes.

Sea Shore Railway.—End Elevation and Transverse Section of Car Gearing through Lower Gear Box.

the sharp edges rounded, but when mercury is used, the crystal is a regular octahedron. Some of the last, when exposed to the air, split, as has happened to some of the diamonds found at the Cape. This was an additional proof to M. Moissan that the diamond is produced under strong pressure.

His conclusion is that at the ordinary temperature carbon



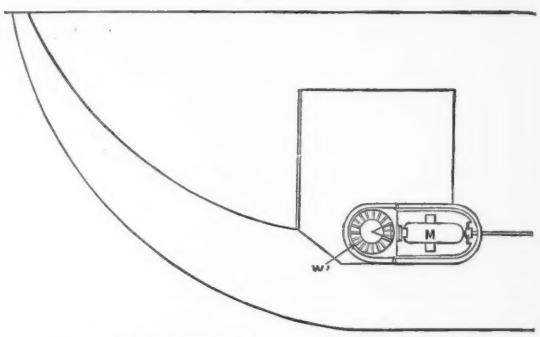
Diamond Making by Electricity.

does not liquefy, but changes at once from a solid into a gas, always taking the graphite form; and that only under pressure does it take the "liquid" form—diamond.

The rest of the lecture was taken up with a review of the other products obtained by M. Moissan by means of the electric furnace, *e.g.*, metallic chromium, molybdenum, and tungsten. These, with many of the oxides supposed to be irreducible, which have yielded to the furnace, were exhibited. He spoke particularly of the excellent qualities of molybdenum steel.

He ran over the properties of the long lists of carbides discovered by him, and produced acetylene gas before the audience by putting some lithium carbide into a jar of water, which thereupon bubbled up, after which he touched the gas off with a match, producing a brilliant flame.

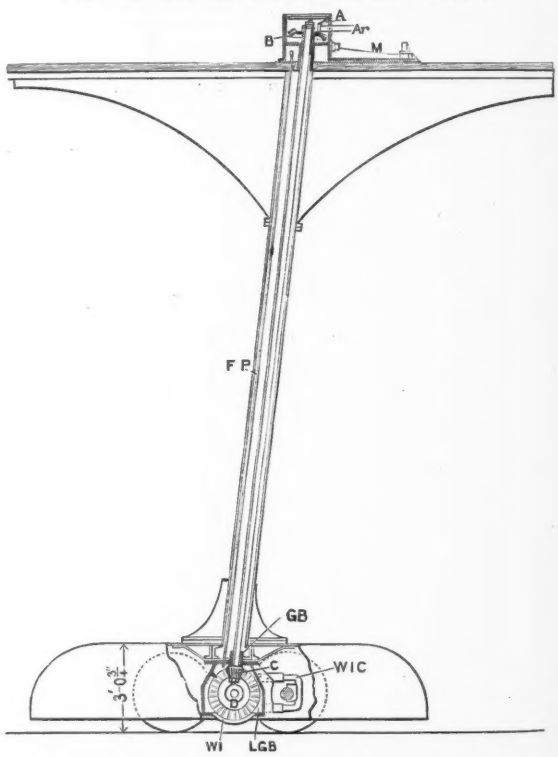
The last experiment was the volatilising of silica, one of the



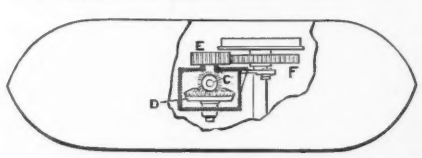
Sea Shore Railway.—Plan of Upper Gear Box.

latest of M. Moissan's scientific achievements. This was done in the electric furnace, a glass globe placed over it catching and condensing the vapours.

Top Gear Box and Motor Base-Plate Combined.



Sea Shore Railway.—Vertical Section through Leg and Upper and Lower Gear Boxes.



F, P, Feed-pipe for Lubricant; G, B, Gunmetal bush; W, I, C, Wrought iron clip L, G, B, Lower gear box; W, I, Wrought iron plate cover, watertight, and box filled with lubricant.

Sea Shore Railway.—Sectional Plan of Lower Gear Box.

The lecturer received a very great ovation, and his trip terminated in a grand banquet, at which leading chemists and electricians were present. The illustrations given in the text show the form of chemical furnace and crucible used by Moissan.

CORRESPONDENCE.

(*Continued from page* 700.)

Telegraphic Communication with the West Indies.

In your last issue Mr. C. W. Earle reminded others than his shareholders that the Government were anxious to have the Bermuda extension, and said there was difficulty in serving the small traffic of the West Indies. He has often been assured the traffic is as small as the rates are high, and he has no one to fear but the French, to whom he does not refer at all. He complains that certain stations do not pay, and everybody knows there is no system clear of non-supporting stations; some are all of that kind. The prevention of rebellion, and the carrying out of police duties for H.M. Government, is an honourable occupation; but, really, is it as bad as this? We shall have Mr. Earle's staff controlling London traffic soon.

The average traffic of £57,000 should be increased by about £16,000 collected for subsidies, and this source of revenue rather mixes up matters, as Mr. Earle views with considerable alarm a new principle which (so he says) has arisen in this country—the proposals of Government to subsidise at the expense of the taxpayers' competition with enterprises such as theirs. This is rather "wobbly" argument by one in receipt of subsidies from the Colonies, which it is to be presumed are a part of the Empire, that another part—Great Britain—must not give a subsidy for a line clearly needed for the safety of the whole. I venture to think that an Empire run on such contracted lines would soon save the British taxpayer much thought—it would vanish. Mr. Earle says the Empire has been built up by individuals. His company is receiving yearly sums from the Governments of Her Majesty's Colonies. Clearly I am sure he does not wish us to take him seriously any longer. It is too near Christmas.

Joseph Rippon.

LEGAL.

THE EDISON GENERAL ELECTRIC COMPANY *v.* THE WESTMINSTER AND VANCOUVER TRAMWAY COMPANY, THE BANK OF BRITISH COLUMBIA, AND OTHERS.

THIS was an appeal which came before Lords Watson, Morris, Hobhouse, and Sir R. Couch (Judicial Committee of the Privy Council), on Saturday last, from a judgment of the Supreme Court of British Columbia, the appellants being the Edison General Electric Light Company, who sought to set aside a judgment of the Colonial Court in favour of the bank for a sum of $261,217, with the certificates registering the judgments against the lands of the Tramway Company. The Edison Company first brought the suit before a judge, who dismissed it with costs, and the same fate awaited an appeal to the Supreme Court. The suit was founded upon the first section of the Consolidated Statutes of British Columbia, which provides that if a person who is insolvent and by collusion with a creditor consents to a judgment in favour of a creditor, which gives that creditor preference over others, such judgment shall be null and void. It was argued on behalf of the bank that the only object of the judgment, as shown by the evidence, was to enable the bank to reconstruct and carry on the Tramway Company, and that there was no fradulent intent, whereas there must be fraud to bring the case within the statute.

Sir R. COUCH, on Saturday, read the judgment of the Court who sat when the case was argued, namely, Lords Hobhouse, Macnaghten, and Davey and himself. Their Lordships held that it was clear that the Tramway Company was insolvent at the date in question, and that they had consented to the judgment. It was plain that there was an agreement which amounted to collusion between the respondent bank and the Tramway Company, the effect of which was that the bank should have a judgment which would give the bank priority over other creditors. The case, therefore, though the object might be to protect the Tramway Company, came within the provision of the section. As to fraud, the act of collusion for the purpose of giving priority to one creditor over another was made a fraudulent act by the Statute. Their Lordships were therefore of opinion that the Statute made the bank's judgment null and void, and they would advise Her Majesty to reverse the decree of the Supreme Court, and to declare the judgment in favour of the bank null and void, and to order the executions and certificates founded thereon to be set aside and cancelled; the costs of the suit, including costs of appeal to the Supreme Court and the costs of this appeal, to be paid by the bank.

JOHN BIRCH & Co., LIMITED, *v.* JENKINS & Co., LIMITED.

IN this case, which came before Mr. Justice Collins last week, the plaintiff had sent a telegraphic cable in one of the defendants' ships from London to Yokohama, and their contention was that in Japan they had to pay, in respect of freight and demurrage a larger sum than was due from them. They now sued to recover the sum paid in excess. Mr. Bigham, Q.C., Mr. Boyd, and Mr. Simmons were for the plaintiffs; and Mr. J. Walton, Q.C., and Mr. Scrutton for the defendants.

Mr. BIGHAM said that there was a correspondence and interviews between the parties as to the terms upon which the cable was to be carried, and the dispute was as to what was the result of this. The cable was to be packed in a water tank, and the freight was to be 37s. 6d. a ton. The defendants contended that freight was to be paid upon a weight of 200 tons, whilst the contention of the plaintiffs was that freight was to be paid only upon the actual weight carried, 145 tons. Then there was a further dispute as to demurrage. The defendants' case was that demurrage was to be paid if more than three days were occupied in putting the cable on board, at the rate of £25 a day; whilst the plaintiffs' contention was that there was to be no demurrage unless the ship was actually detained through the shipping of the cable. The plaintiffs had to pay at Yokohama £475 in respect of the cable, whilst they asserted that the proper sum to pay was £203 2s. 6d., and they now claimed the sum paid in excess. The defendants paid into Court £75, and a further sum of £35, so that the only sum now in dispute was £93 2s. 6d.

Mr. Justice COLLINS having heard a great deal of evidence and much argument, came to a conclusion partly in favour of one litigant and partly in favour of the other; and the result was that there was judgment for the plaintiffs for £44 3s. 6d. beyond the amount paid into Court.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

WEEK ENDING NOV. 24TH, 1895.	£	s.
Aden	42	0
Algoa Bay	912	0
Bangkok. Elec. launch	150	0
Buenos Ayres	80	0
Bombay	65	0
Bologna	110	0
Brisbane	75	0
Brussels	528	0
Calcutta	125	0
Cape Town	740	0
Carthagena	11	0
Cienfuegos. Sub. cable	32,220	0
Colombo	44	0
East London	930	0
Flushing	11	0
Hong Kong	24	0
Lima	85	0
Malta	270	0
„ Teleg. mtl. ...	16	0
Melbourne	60	0
Monte Video	50	0
Oporto	80	0
Reval	110	0
Rio Grande	23	0
Shanghai	13	0
„ Teleg. cable .	5,149	0
Sydney	44	0
„ Teleg. cable ...	800	0
St. Petersburg. Teleg. mtl.	830	0
St. Lucia. Teleg mtl....	300	0
Suez	12	0
Yokohama. Teleg. mtl.	136	0
Total	£44,045	0

WEEK ENDING NOV. 24TH, 1896.	£	s.
Albany	40	0
„ Teleph. mtl. ...	11	0
Amsterdam	50	0
Beria. Teleg. wire ...	430	0
Bilbao. Teleg. mtl. ...	126	0
Bombay	253	0
Brussels. Elec. cable...	1,310	0
„ Teleg. mtl. ...	52	0
Calcutta	213	0
Cape Town	306	0
Colombo	19	0
Delagoa Bay	64	0
Durban	522	0
East London	214	0
Flushing	285	0
Genoa	54	0
Launceston	175	0
Madras	10	0
Orotara	104	0
Port Elizabeth	479	0
Rio Grande du Sol ...	80	0
Rockhampton	160	0
Rotterdam	17	0
Singapore	265	0
Sydney	400	0
Trinidad	22	0
Wellington	219	0
Total	£5,880	0

Foreign Goods Transhipped.

Brisbane.	Teleph. mtl.	£12	0
Freemantle	„ „	38	0
Sydney	„ „	265	0
	Total	£315	0

Bankruptcy Proceedings.—Charles Edmund Davis, lately trading as Davis & Son, electrical gas engineer and general smith, 2, Hay Hill House, Hay Hill, and 12, Walcot Street, Bath, and Henrietta Mary Churchill, trading apart from her husband, at the places above mentioned, and under the above-mentioned style, have executed a deed of assignment, with a view to the payment of the creditors in full, by instalments. The trustee under the deed is Mr. Alfred C. Turpin, accountant, 41, Broad Street, Bath. The unsecured liabilities are returned at £302, and the assets, after deducting the claims of preferential creditors payable in full, are estimated to produce £250. There are also fully secured creditors amounting to £510.

Blackpool.—Mr. Quin, the borough electrical engineer, will explain the new charges for electric light to a meeting of the Tradesmen's Association on Tuesday, December 8th.

Books Received.—

Practical Electricity. Vol. I. By W. E. Ayrton, F.R.S., &c. Completely re-written. Published by Cassell & Co., Limited, London.

Commercial Organisation of Factories. By J. Slater Lewis. Published by E. F. & N. Spon, London.

Induction Coils and Coil Making. By F. C. Allsop. Published by E. F. & N. Spon, London.

Carriages without Horses shall Go. By A. R. Sennett. Published by Whittaker & Co., London.

Galvanism in the Treatment of Neuritis, &c. By Carey Coombs, M.D. Bristol: John Wright & Co.

Electricity in Electro-Therapeutics. By E. J. Houston and A. E. Kennelly. New York: W. J. Johnson Company.

Elementary Engineering. By J. S. Brewer. London: Crosby, Lockwood & Son.

Metric System of Weights and Measures. By W. H. Wagstaff. Published by Whittaker & Co., London.

Constructional Steel and Ironwork. By Francis Campin, C.E. Published by Crosby, Lockwood & Son, London.

Autocars. By D. Farman, M.I.E.E. Published by Whittaker and Co., London.

Cox-Walker's.—This firm, of Darlington, who have just completed the telephone and fire alarm contract at Brook Hospital, have obtained the contract for electrically lighting the Armagh Asylum from H.M. Board of Control, Dublin. The tender of the same firm has also been accepted by the North of England School Furnishing Company, for electrically lighting their new building at Darlington; and the Government of the Cape of Good Hope, through their Agent-General in London, have placed with Messrs. Cox-Walker an order for one of their electric "silver medal" Tell-tales for recording the night and day movements of hospital and other attendants, policemen, watchmen, &c., when on duty.

Dinner.—The employés and friends of W. H. Allen, Son, and Co., of Bedford, to the number of 250, met for the first annual dinner of the Queen's Engineering Works Cricket Club at the Town Hall, Bedford, last Saturday. There were present Messrs. W. H. Allen, Richard Allen, Harold Allen, C. C. Hawkins, Mr. Pym, M.P., and the Mayor.

Electricity in Tin Plate Works.—In addition to the contract for an electric lighting and motive power plant at the Albion Steel Works, Britonferry, mentioned in our last issue, Messrs. Herbert Lewis & Fletcher, of Cardiff, have secured a contract for putting down a complete plant at the Britonferry works of the Baglan Bay Tin Plate Company.

Electrical Engineering in Germany.—A company has just been formed in Berlin, with a capital of £100,000, to be known as the Siemens Electrische Betriebe Gesellschaft. The object of the company is to finance some of the electrical undertakings of Messrs. Siemens & Halske of that city.

Expiration of Lease.—Mr. L. C. H. Mensing, late of the City Electric Light and Power Engineering Works in Worship Street, E.C., announces that owing to the expiration of his lease, he has removed to 11, Queen Victoria Street, E.C., where he will continue to carry on business as usual.

Electric Cooking. — An announcement is made by Messrs. Crompton & Co., Limited, to the effect that they are increasing the discounts to the trade on their electric kettles, heaters, hot plates, and radiators. They have also issued a set of lists giving details and prices, as well as illustrations, of their various electric heating and cooking apparatus.

Gas.—A house was wrecked, and three persons severely injured, by a gas explosion on 17th inst., at Heanor.

Last week, a gas main at South Bank, near Middlesbrough, burst, three explosions resulting. Two persons were injured, and damage to the extent of about £1,000 was done. The supply at the gas works was stopped to prevent further explosions, and in consequence the town was left in darkness.

A Piccadilly gas explosion last Saturday wrecked some premises and injured a child.

An explosion, due to leakage, occurred at 29, Milsom Street, Bath, doing damage to shop premises. A lad sought for an escape with a light.

A lady and her maid have been poisoned while asleep in bed at Bath, by an escape of gas from a pendant in a room beneath.

Liquidation Notices.—At extraordinary meetings of the Arc Accumulator Company, Limited, held at 39, Victoria Street, S.W., on October 26th and November 12th, it was resolved to wind up the company voluntarily, Mr. E. R. James being appointed liquidator.

At meetings of the Foreign and Colonial Arc Accumulator Company, held at the same place on the same dates, similar resolutions were passed.

Luna Arc Lamps.—We understand that since the commencement of the present season the sales of the "Luna" self-focussing arc lamps by the Electrical Company, Limited, have exceeded an average of 200 per month.

Meters for Sale.—The Bradford Corporation has for sale a number of electric meters, particulars of which will be found in our "Official Notices."

Price Lists.—Messrs. J. Goodman & Co., of New Broad Street, E.C., have sent us advance copies of their lists of cut-outs, switches, ceiling roses, pendants, and incandescent lamps; also enamelled iron shades, and "Meteor" arc lamps.

The Stewart enclosed direct-current arc lamps are explained, instructions for running given, and the advantages enumerated in a pamphlet which has been issued by the Stewart Electrical Syndicate, Limited. The closing chapter deals with street lighting on this system. Another list, issued by the same syndicate, describes field and motor speed-regulating and other rheostats, theatre dimmers, electric heaters, &c. These articles are illustrated and priced.

The U.S. General Electric Company.—"It is anticipated," says a financial contemporary, "that as the result of the working for the year ending January 31st next, the General Electric Company, of America, will have a surplus of $1,250,000, after meeting the fixed charges."

Varnish.—The Sterling Varnish Company, of Pittsburgh Pa., has sent us a list describing their insulating varnish, also a copper-coated sample. It is used by a number of prominent American electrical contractors for armature, field coil, and other classes of work.

ELECTRIC LIGHTING NOTES.

Bermondsey.—The General Purposes Committee desire an interview with the County of London and Brush Company's representative regarding their application for a provisional order.

Boston.—An expert report on a scheme for lighting the docks and the town by electricity, are to be considered by the Council. The Dock scheme costs £1,000, and the town £20,000. Committees are understood to have reported favourably.

Clapham.—The electric lighting of the Library was mentioned by Dr. Maxwell and Mr. Morgan at the last meeting of the Library Commissioners, and the matter was deferred for a time. The doctor could not say what the estimated cost would be, but once this gets to the ears of electric wiring contractors, we presume they will see that he has some estimates in his possession before the next meeting of the Commissioners.

Coolgardie.—The Municipal Council of Coolgardie have decided that the number of arc lamps in the town be increased from eight to twenty, and a further contract with the Westralian Electric Lighting and Supply Company has been accepted.

Dover.—Holy Trinity Church is now being fitted up for electric lighting.

Germany.—From a note which appears in the *Journal* of the Society of Arts, it would seem that in Germany gas, for both lighting and power purposes, is leaving electricity well behind, though, judging by their success, it is clear that there is ample scope for both illuminants. The figures given show that the consumption of gas in the German Empire has increased very considerably during the decade ending 1895. The Berlin Municipal Gas Works, and the English Gas Company at Berlin produced approximately 30,000,000 cubic metres more in 1895 than in 1885. These figures are of special interest, in view of the fact that the Berlin electric plants were erected about 1885. The *Electrotechnische Zeitschrift* recently published statistics relating to 36 works for the supply of electricity in Germany, half of them being municipal. It is recorded that in 1895 there was a satisfactory increase in the demand for current as compared with the previous year; at the same time there was a similar increase in the consumption of gas. "According to one writer, the future of the gas industry in Germany now stands on a firmer basis than that of electricity. Incandescent gas burners, gas stoves, and gas engines are stated to have left their rivals far behind. In spite, however, of all technical improvements in the lighting industry, and the enormous progress of gas and electric lighting during the last 10 years, the consumption of petroleum in Germany has not only kept up, but it has increased steadily for the last 30 years."

Glasgow.—The salaries of the two assistant engineers at the Waterloo Street Electric Lighting Station have been increased, as from June 1st last, from £200 to £225 per annum. Mr. Norman Macfarlane and Mr. Wm. Jackie are the assistants.

Glossop.—Mr. W. H. Druce, consulting engineer, Manchester, has offered to supply the Council with an estimate of a scheme for supplying electric energy for the borough, with details as to the cost and probable revenue. The subject has been deferred.

Hammersmith.—The London County Council, on Tuesday, agreed to grant the Vestry a loan of £38,935 for electric lighting.

Hampstead.—Messrs. Dellagana & Co. are claiming £11 odd for loss of time and delay of work which they allege was caused by a breakdown on the Vestry's mains. This is rather an important point, and as the Vestry intends resisting the claim, it is not unlikely that litigation will ensue. Supposing all the consumers in Cheapside and that neighbourhood who were inconvenienced by the recent 45 minutes' failure in the City supply were to present claims!

Particulars of the scheme for the extension of the street electric lighting are to be prepared by the Lighting Committee.

Exeter.—The City Council are contemplating the improvement of Northernhay. The grounds are to be illuminated with at least seven electric arc lamps, at an estimated cost of £113.

Hull.—The Electric Light Committee has adopted Mr. Robert Hammond's report on the electrical engineer's (Mr. Barnard) extension scheme. It was stated at the meeting that Mr. Hammond had "practically confirmed the scheme of the engineer." The Council is to be asked to instruct the Committee to carry the report into effect, subject to such modifications as they might deem expedient.

Islington.—The machine shop at the central station is to be fitted with the requisite tools and appliances to meet the requirements of the electrical engineer, at a cost of £250. Mr. Lambert said the purchase would mean a saving of money, and the tools would be useful in case of emergency.

Leith.—The Town Council has resolved, by 13 votes to 3, to proceed with a provisional order for the electric lighting of 15 of the principal streets of Leith. It was stated that the installation would cost from £30,000 to £35,000.

London.—The Commissioners of Sewers announce their intention to prescribe the undermentioned fees for the testing of consumers' wires and fittings agreeably to the provisions of No. 43 (A) of the regulations made by the Board of Trade under the Electric Lighting Act, viz.:—For a test not occupying more than two hours, 10s.; for a test taking more than two hours—a charge for the whole time absorbed in testing at the rate of 5s. per hour. "Anybody objecting to the above fees may signify the fact to the Board of Trade within one month from this date."

The work of re-arranging and re-installing the wiring at St. George's Church, Hanover Square, where the recent fire took place, has been entrusted to Messrs. Drake & Gorham.

Moss Side.—The offer of Mr. H. J. Warden-Stevens to make a preliminary report and estimate *re* electric lighting has been accepted.

Provisional Orders.—Last Friday's *London Gazette* contained notices of the following applications which are to be made for provisional orders during the approaching session:—

Stretford District Council, electric lighting powers.
Moss Side District Council, " "
Barking District Council, " "
Wimbledon District Council, " "
London (St. George-in-the-East; St. Matthew, Bethnal Green; the Hamlet of Mile End Old Town; and the district of Limehouse), electric lighting powers to the County of London and Brush Company.
Huyton-with-Roby, Rainhill, Whiston, Knowsley, and Eccleston, electric lighting powers to the British Insulated Wire Company.
Garston District Council, electric lighting powers.
Newington Vestry, " "
Withington District Council, " "

Tuesday's *London Gazette* contained the following notices:—

London (Holborn; Charterhouse; and St. Leonard, Shoreditch), electric lighting powers to the County of London and Brush Company.
Llandrindod Wells, electric lighting powers to the Llandrindod Wells Electric Light and Power Company.
Ambleside, powers to the District Council for electric lighting.
Pembroke, powers to J. C. Howell, of Llanelly, for electric lighting.
Wrexham, powers to the Corporation for electric lighting.
Bermondsey, Rotherhithe, Lambeth, and Newington, powers to the County of London and Brush Company for electric lighting.
Ipswich, powers to Corporation for electric lighting.
Darwen, " " " " " "
Tonbridge, powers to District Council for electric lighting.
Dorking, " " " " " "
Weymouth, powers to Weymouth Consumers Gas Company for electric lighting.
Tenby, powers to J. C. Howell, of Llanelly, for electric lighting.
Bangor, powers to Corporation for electric lighting.
Fulham, powers to County of London and Brush Company for electric lighting.
London (St. George-in-the-East; St. Matthew, Bethnal Green; Mile End Old Town; Limehouse and Poplar), powers to the County of London and Brush Company for electric lighting.
Farnworth, powers to the District Council for electric lighting.
Bexhill, powers to Earl de la Warr and R. Kersey for electric lighting.

Rotherhithe.—Consideration of a letter from the County of London and Brush Company, asking for formal consent to their application for a provisional order, has been adjourned by the Vestry.

Shoreditch.—The Lighting Committee considers the Vestry should oppose the County of London and Brush Company's proposal to apply for a provisional order in respect to a portion of this district.

Stalybridge.—An installation of the electric light is to be laid on in the offices of the Globe Ironworks. Other alterations are also being made. Why not take advantage of this opportunity to instal electric motors, as other iron and steel companies are doing?

Switzerland.—The St. Gothard Railway Company has decided to light its railway station at Ersfeld by electricity. A central station is about to be erected at Bex. Water-power will be utilised.

Torquay.—The tenders which it is proposed to accept for the electric lighting works amount to about £20,500. The estimate of the engineer was £22,300.

Worcester.—New mains are to be laid at a cost of about £300.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Accident at Bristol.—On 19th inst. some men were at work on a tower waggon in West Street, engaged in connecting the wires of the Eastville section with those of the St. George, when one of the wires suddenly broke, and two of the men were thrown to the ground, a distance of about 15 feet, and sustained severe injuries.

One of the men (R. A. Davies) has since died, and the jury returned a verdict of "accidental death."

Blackpool.—A special meeting of the town council was held on Monday to discuss a scheme for the widening of the promenade. This scheme provides for a 15*ft.* footpath on the easterly side, a roadway 55*ft.* wide, a 10ft. island footway, a double line of electric tramways, and a promenade 42*ft.* wide on the outer or westerly side, the whole width being not less than 140ft. The estimated cost is £300,000, and the committee's recommendation was that a provisional order should be obtained to carry out the work. The scheme was adopted.

Bradford.—A report has been presented to the Gas and Electricity Committee of Bradford Town Council by Mr. A. H. Gibbings, the borough electrical engineer, on the subject of the adoption of electricity as the motive power for tramways to Great Horton and Bolton. Mr. Gibbings deals, says *Daily Tenders and Contracts*, with the probable cost of working, the estimate being based to a certain extent upon the experiment tried some years ago with the overhead electric traction between Forster Square and the Grammar School. He points out that the Corporation possess many advantages now which they did not possess at that time. Amongst them are a working pressure of 500 volts instead of 300, the present central station having sufficient power to drive a 10 minute service of three times the number of tramcars now running on all the systems in Bradford. While supplying current from the electricity works, the working of the tramways could, if desired, be entrusted to a private company, but it would be more profitable for the Corporation to themselves manage the whole of the working. The total cost of working a 15 minute service on the Horton route is estimated at 9·43d. per car mile, and for a 10 minute service at 8·25d. The total capital cost for the Horton section is placed at £18,660, of which £2,000 is for sheds and offices, £1,600 for four cars at £400 each, and £15,060 for rails, cables, paving, &c. The length of the Bolton section being considerably less, the cost per mile per car is calculated to come out at 25 per cent. more than on the Horton section. If the two sections were worked conjointly the cost would probably be reduced to 8d. per mile per car. The additional capital required for a 10 minute service, as against a 15 minute service, would be small compared with the material reduction in the mileage cost. As for the effect on the electricity works a charge of 1½d per unit would yield a profit of ½d. per unit, or an income of £277 1s. 8d. on a sale of 133,000 units in the year, which would be gained without further expenditure on the works. The report is favourable to the adoption of electricity for the proposed new sections of tramway.

Bristol.—A meeting of ratepayers on Tuesday seemed distinctly in favour of the scheme of the Tramways Company, and against the proposals of the Corporation, to which we referred last week.

Cardiff-Penarth.—The Cardiff General Purposes Committee has received communications from Messrs. Vachell & Co., solicitors, as to a proposed electric tramway between Cardiff and Penarth, asking for sanction of the Corporation to a provisional order for it. In one of the letters it was explained that the scheme was promoted by a syndicate, and that while they sought powers to establish a generating station of their own they would be prepared to negotiate with the Corporation for receiving a supply of electric energy from the Corporation Works. It was decided to send the letters to the Parliamentary Committee for consideration and report.

Dublin.—The Dublin United Tramways Company has given notice of application for power to use electrical and other mechanical power on their tramways, construct generating stations, &c., &c.

Electric Motors.—We understand that Messrs. Workman & Clark, Belfast, are going to adopt electricity for driving their machine tools.

France.—Some trials are about to be made in the Rue de Maubeuge, Paris, with the new Westinghouse electro-magnetic traction system, a length of 500 metres being about to be constructed on this plan.

Electric Tramways in Europe.—The *Journal des Transports* publishes some interesting statistics showing the rapid development of electric tramways during the past year. It appears, says the *Times*, that the number of lines in working order has increased from 70 to 111, while the total length of lines has gone up from 437½ miles to 564. Germany heads the list with a total length of 255 miles and 857 auto-motor vehicles, France being second with 82½ miles and 223 vehicles, while England is third with 67 miles and 168 vehicles, Switzerland coming fourth with 29½ miles and 86 vehicles. Bulgaria and Denmark are the only countries which have no line with electric traction. Of the 111 lines now being worked, 91 are driven by wires overhead, while nine have a central rail, eight accumulators, and three a conduit system.

Glasgow.—As we predicted, Mr. Young, the general manager of the tramways, and the engineer, have returned from their electric tramway tour in the United States fully convinced that the overhead trolley is much to be preferred to horse and cable traction. The reporters spent five weeks in the States visiting all the principal cities and towns, and seeing all that was to be seen in the way of mechanical traction. They found that the cable had latterly made no progress whatever. On the contrary, a number of cable lines had been converted so as to be used for electric traction. The application of electricity for purposes of tramway traffic was being universally adopted. Mr. Young hopes to be able to present his report in the course of a week. In the meantime he says, generally, that in his opinion the overhead trolley system seemed to be much preferable to horse haulage.

Grimsby—Cleethorpes.—The Provincial Street Tramways Company have decided to apply for a provisional order to enable them to extend their Grimsby line into the old portion of Cleethorpes. Electricity will be used, and if satisfactory it will also be employed on the existing line.

Italy.—A scheme has been submitted to the Municipal Authorities of Rome for a projected electric tramway between that city and Frascati. The line would be about 12 miles long.

Motor Car Matters.—The New Motor Car Institute offers a gold medal and money prizes for the best original designs for motor carriages, for the best model of a motor carriage, and for an essay on the best motor for propelling such carriages. The London Electric Omnibus Company, Limited, will also offer three £50 prizes for the best design of an omnibus to carry 26 passengers, for an omnibus suitable for railway purposes and for an electric cab.

The Hon. secretary of the Motor Car Club announces that it is intended to hold a great motor car competition some time in May next year. The tests will be given on the point of design of the motor car, consumption and cost of fuel and other points, but the principal point will be speed. It is proposed to offer for competition £2,000 in prizes. Notice is given early in order to enable English manufacturers to be prepared with their productions in good time. If sufficient entries are received the committee will confine the competition to British-made motor vehicles. A special prize will be offered to the first mechanically propelled vehicle which accomplishes a mile in a minute.

Paris.—A new electric tramway scheme was discussed at last week's meeting of the General Council of the Seine, it being a proposal to work the tramway between the Bastille and Charenton by electricity. Some opposition to the use of overhead wires was manifested, but finally the council decided to accept the offer of the tramway company to construct at their own expense, and as a tentative undertaking, to last six months, the electric system proposed, providing the overhead wires are placed at a height that will allow of any conveyance passing easily beneath. The tramway company have undertaken to reduce the fares.

Parliamentary Powers.—The *London Gazette* contains notice of applications to be made during the coming session for the following provisional orders:—

Birmingham, Wolverhampton, and District.—Powers for the purchase of the undertakings of several tramways companies, from the said companies, or from the British Electric Traction Company, alteration of gauge, adaptation for mechanical power, electricity being used, erection of electric generating station, abstraction of water from the Birmingham Canal for the purpose of such station, &c., &c.

Birmingham.—Powers to the City of Birmingham Tramways Company, Limited, to purchase, construct, and equip electrically various specified tramways.

Blackpool Corporation.—Powers to construct tramways in the Borough, to be worked by "animal, steam, gas, oil, compressed air, wire or rope cables, electricity, or any mechanical power."

Bradford.—Powers to the Corporation to construct tramways, electricity, cable, or other power being used.

Brompton and Piccadilly Circus Railway.—Powers to a company to construct an underground railway from Piccadilly Circus to South Kensington. The standard gauge would be adopted, and the motive power to be employed will be "electricity or such other motive power as the Board of Trade may sanction."

Central London Railway Company.—Powers as to alteration of station in Oxford Street, acquisition of additional lands, application of capital, &c., &c.

Halifax.—Powers to the Corporation to construct tramways, to be worked by electricity or other mechanical power.

Huddersfield Corporation.—Powers to construct tramways in the Borough, to be worked by "animal, steam, gas, oil, compressed air, wire or rope cables, electricity, or any mechanical power."

Leeds.—Powers to the Corporation to purchase tramways, and work by electrical or other power.

Liverpool.—Powers to Corporation for the purchase of certain tramways, and to use electrical or other mechanical power.

Liverpool United Tramways and Omnibus Company.—Powers to work all tramways in Liverpool, Bootle, and Litherland by electrical power, and to construct the necessary works.

London.—Powers to incorporate a company to construct a railway from Praed Street, Paddington, to Willesden, "electricity, steam, or other motive power" being used.

Manchester.—Powers to the Corporation to work tramways, electricity or other mechanical power being used.

Manchester Carriage and Tramways Company.—Powers to construct various tramways in the Manchester district, to be propelled by animal or electrical or other power. Also to supply electrical energy for power purposes.

Metropolitan District Railway Company.—Various powers, including authority to enter into agreements as to the supply of electricity or electrical energy, power to work existing railways by electric power, &c., &c.

Middlesbrough, Stockton-on-Tees, and Thornaby.—Powers to the Imperial Tramways Company to construct tramways, using electrical or mechanical power, and supplying electrical energy to the public.

Moss Side.—Powers to the District Council to construct certain tramways, and work by animal or mechanical power.

Neath Corporation.—Power to purchase the Neath and District Tramways, construct new tramways, and to work them by any of the powers specified. "In the case of electricity, such power is intended to be applied by means of the rails of the tramways, and of conductors placed under, on or above the surface of the streets, in connection with a generating station or generating stations, or to be carried with the carriages."

Newport Corporation.—Powers to work and construct tramways, and to use electricity or other motive or animal power.

Reading and Caversham.—Powers to the Reading Tramways Company, Limited, to construct street railways, electrical or other mechanical power being used.

Swansea.—Powers to the Swansea Improvements and Tramways Company to use electricity on tramways, and to enter into agreements with the Corporation.

Withington.—Powers to the District Council to construct certain tramways, to be worked by animal or mechanical power.

Worcester.—Powers to the Worcester Tramways, Limited, to construct street tramways, and work by means of electrical or other motive power.

Yarmouth and Gorleston.—Powers to the Yarmouth and Gorleston Tramways Company, Limited, to construct new tramways and to use electrical or mechanical power thereon.

York.—Powers to the City of York Tramways Company to work tramways by mechanical and electrical or other motive power except steam.

Thanet.—The Isle of Thanet Light Railways (Electric) Co., having decided to promote a Bill for the purpose of obtaining powers for the construction of electric tramways, have instructed an engineer to prepare plans for carrying out the scheme.

The Cheltenham-Winchcombe Scheme.—Notification is given of an intended application to the Light Railway Commissioners for an order authorising the construction of a light railway from the Midland Station, Cheltenham, to the village of Winchcombe, Gloucester, the proposed terminus being "near St. Peter's Church, opposite the site of St. Mary's Abbey." "Electricity, air, or other motive power," as may be agreed with the Corporation of Cheltenham, will be used.

Thornaby.—The Town Council on the 20th inst. considered an application from the Tramways Company for the reconstruction and extension of the tramways in the borough, and their operation by electric traction. The application was agreed to conditionally, subject to the consent of the North Riding County Council, to the laying of the lines down to Middlesbrough on the main road.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Amazon Company's cable Parintins-Itacatiara	May 5th, 1896 ...	...
Pará-Maranham	Oct. 8th, 1896 ...	...
Chio-Tenedos	Nov. 24th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok ...	Nov. 17th, 1896 ...	Nov. 18th, 1896.
	Nov. 25th, 1896 ...	Nov. 25th, 1896.
Bolinao - Manilla. Telegrams sent by rail	Nov. 21st, 1896 ...	Nov. 22nd, 1896.

American Cable Across the Pacific.—By advices from Honolulu, dated the 12th inst., we are informed that the Hawaiian Government was then considering a petition to extend for the term of one year the concession granted on August 12th, 1895, to Colonel Spalding. This concession, it will be remembered, was for a submarine cable to be laid from San Francisco to Honolulu, with liberty to extend the line to other parts of the Pacific; the company to receive from the Hawaiian Government an annual subsidy of $40,000 (gold) for a period of 20 years, on condition that the construction of the cable should be started not later than May, 1897. Mr. Foster, former Secretary of State in the United States Government, is reported to be at Honolulu looking after the interests of the cable company. This Mr. Foster it was who, on February 14th, 1893, concluded a treaty of annexation on behalf of the United States Government with the Provisional Committee who had overthrown the monarchy of the Hawaiian Islands, a treaty which, there is little doubt, would have been ratified by the United States Senate had not the election gone against President Harrison at that time. Later news assures us that the present Hawaiian Government have decided to refuse the application made to extend the time of the exclusive franchise of a cable from Honolulu to Australia and Japan. At first sight it might appear that the action of the Hawaiian Government has relieved the Briti-h Pacific cable scheme from a possible inconvenience; but, on looking more closely into the matter, we find this is not the case, as the rebuff offered to the Spalding project is probably due to the successful management of another American company, the Pacific Cable Company, of New York, which, with a strong financial and political backing, has already been successful in the American Congress in rebutting the claims made by the Spalding Company. It was then pointed out that this company was supported by English financiers, who were interested in hampering, as much as possible, the success of the British Pacific cable enterprise, and who hoped to achieve this object by giving encouragement and support to the company represented by Colonel Spalding, the Hon. Abram S. Hewitt, and others. As the extension of time asked for has not been granted by the Hawaiian Government, the concession will, in all probability, lapse, thus leaving the ground open for the action of the New York Pacific Company. The cable route from San Francisco to Honolulu has, by order of the United States Government, already been very thoroughly surveyed, and is most favourably reported upon, so that the whole affair is now ready for decision during the approaching session of the U.S. Congress.

Australasian Conference.—The Inter-Colonial Conference of Postmasters-General has concluded its sittings at Sydney. It was decided to adopt the universal telegraphic code from January 1st next.

Brighton.—There was a lengthy discussion at the Works Committee meeting the other day on underground *v.* overhead wires. It arose upon applications from the Postmaster-General for permission to construct overhead telegraph lines.

Chicago Fire Day.—During the recent celebration of the twenty-fifth anniversary of the great Chicago fire, the telephone building in Washington Street arranged a large transmitter over the street, so as to catch the cheers and music of the procession as it passed. The transmitter, according to a contemporary, was connected to all the telephone lines in the country, and as the procession passed its cheers were heard throughout the Union.

Interesting to Telephone Users.—It is a recognised rule of the National Telephone Company, which subscribers to a certain extent abide by, that a subscriber shall not allow a non-subscriber to use the telephone system. Were it not for this regulation it is more than likely that there would be a great number of non-paying users added to the service, such, for instance, as those who may have occasion now and then to use the telephone, but whose requirements may not be so extensive as to warrant the high charge made in London for a year's use. There are certain circumstances under which this rule would seem rather oppressive, though for some reasons it is a necessary arrangement for the company's protection, but these points are not of sufficient importance for us to go into here. We have, however, been led to make these remarks by an interesting case which has just been decided by the Supreme Court of Indianapolis. The facts are given as follows:—A physician had a difference with the telephone company, and in consequence gave instructions for a discontinuance of the service. Subsequently, when at a friend's house, he wanted to telephone a short distance for his carriage to be brought. His friend very willingly allowed him to use his telephone. Whether there was an evil spirit on the wires, or whether the doctor's voice was recognised we are not told, but for some reason the telephone company refused to connect their subscriber's telephone with the stable unless that gentleman pledged himself that his telephone was not to be used by anyone except himself. This undertaking the subscriber declined to give, and the company refused to make the connection. The Supreme Court, before which the case was tried, decided that the telephone company had no right to act in the way it did, for the contract implied that the necessary connection must be made without discrimination or partiality. Whether Indianapolis law would be British law is another matter.

The Pacific Cable.—The Pacific Cable Conference met again on Monday at the Colonial Office, under the chairmanship of the Earl of Selborne.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bury (Lancs.).—November 30th. The Corporation wants tenders for the wiring of the municipal offices, Bank Street and Parson's Lane, Bury. Copy of specification and form of tender may be obtained on application at the office of the Borough Engineer.

Denmark.—December 4th. Tenders are invited by the Municipal Authorities of Copenhagen for the supply and erection of the necessary boilers, engines, dynamos, mains, &c., required in connection with a projected central electric lighting station at Vesterbro. Tenders to be directed to the Fourth Division of the Magistracy, Copenhagen.

Deptford.—November 30th. The Commissioners of Baths and Washhouses for the Parish of St. Paul, Deptford, invite tenders for proposed electrical installation at the Deptford Public Baths now in course of erection. Particulars of Mr. Thomas Dinwiddy, architect, Greenwich, and at Whitehall, S.W.

France.—December 8th. Tenders are being invited by the French Post and Telegraph authorities in Paris for the supply of seven lots of telephone cables. Tenders to be directed to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Londonderry.—December 1st. The Corporation wants tenders for the supply of carbons for one year, from January 1st, 1897. Particulars to be obtained from Mr. John Christie, city electrical engineer, Guildhall.

Southampton.—December 4th. Tenders are invited by the Corporation for the supply and laying of insulated electric mains, conduits, and drawing-in boxes. Further particulars from Messrs. Kincaid, Waller & Manville.

Southampton.—December 4th. The Corporation invites tenders for the erection of buildings for an electric generating station. Engineers, Messrs. Kincaid, Waller & Manville.

Spain.—November 29th. The Municipal Authorities of Valdepeñas (Cuidad Real province) are inviting tenders for the concession for the electric lighting of the public streets of the town. Tenders to be sent to the Secretariat del Ayuntamiento de Valdepeñas (Cuidad Real).

West Looe (Cornwall).—November 28th. Tenders are invited for the lighting of the parish with either gas, oil, or electricity, for the Parish Council. Information may be obtained of Mr. William Hicks, hon. clerk.

York.—November 30th. The Corporation invites tenders for the supply and erection of a complete electric lighting plant for the Borough, also supplying and laying mains, ditto arc lamps, and running the whole system. Further details from Prof. Kennedy.

CLOSED.

Spain.—A company known as the Sociedad "La Hidro-Electrica" has secured a 5-years concession for the electric lighting of the public streets of Ayelo de Malferit (Valencia province).

DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Members, associates, and friends foregathered at the Criterion Restaurant, on Wednesday evening, to do honour to Messrs. Spiers & Pond's catering. From a numerical point of view, the gathering was highly successful.

Dr. John Hopkinson, the worthy President of the Institution, presided over the function, there being about 200 persons present. Among the most notable guests were the Duke of Norfolk, Postmaster-General, Mr. J. Wolfe Barry, C.B. (President of the Institution of Civil Engineers), the Marquis of Tweeddale, Sir W. H. White, Mr. E. W. Richards (President of the Institution of Mechanical Engineers), Captain W. D. W. Abney (President of the Physical Society), and many others.

The toasts were few, the speeches short, and uncommonly bad.

Prof. Ayrton, in proposing the "Learned and Engineering Societies," said the Institution of Electrical Engineers had not yet left the protection afforded by its parent, the Institution of Civil Engineers. This month the Institution had been established a quarter of a century, and he hoped that when they left the parent roof they would receive a hearty God speed.

Dr. Frankland briefly responded for the Royal Society, and Mr. John Wolfe Barry, in his reply, said he could

not help being struck with the number of engineering societies, having a probable membership of 11,000, and this enormous number of highly trained intelligencies were pressing forward and lifting up the lamp of progress.

Mr. Alexander Siemens proposed the toast of "The Guests," which was responded to by the Duke of Norfolk.

The Marquis of Tweeddale, in proposing the toast of the evening, "The Institution of Electrical Engineers," said that they were impressed by the advantage of the uses to which electricity had been applied, whether it was regarded as an illuminant, as a motive power, or as a means of conveying the thoughts and wishes of men.

In replying, Dr. John Hopkinson remarked that all would agree that it was desirable for the world at large that the commercial supremacy of the British Empire should be maintained. That supremacy was initiated by our being the first to employ, on a large scale, the resources of coal at our disposal, and to-day it was maintained largely by the fact that coal was the basis of the means of communication and of most of our industries. If coal were to cease to be necessary for those purposes, would the Empire still maintain its commercial supremacy? He doubted it. In the Falls of Niagara there was a waste of more power than could be derived from all the coal that could be raised throughout the world, and they well knew that there were many other falls in the world than those of Niagara. He ventured to say that it would be the work of the engineer in future to utilise those falls for the acquisition and transmission of power for various purposes. When that came about, what would our position be? We should surely have to do one of two things —we should either have to live on our accumulations, or we should have to flit. In either case the commercial supremacy of Great Britain would have gone.

NOTES.

Our Leyton Description.—Two unimportant errors crept into our account of the Leyton Station last week. The gas installation of the Midland Railway Company, which we referred to, is at Leicester, and not Derby. We also stated that when running direct, the batteries were connected across the outers. As the pressure across the outers at the station end varies from 300 to 350 volts, and there only being 85 cells of battery, it is clearly impossible to place this number of cells across the outers. The correct statment is this: The battery is across the + and middle wire, and a switch is used for cutting in or out cells as required to keep the battery pressure the same as distributors. It is possible to cut out the battery altogether during the time the dynamos are running, leaving the transformers to do all the balancing; but, as a rule, the battery is left in circuit, as it helps to overcome the fluctuation due to the explosions in the engine cylinders.

Tramcar Traction.—Before the Philosophical Society of Glasgow, on 18th inst., Prof. Watkinson read a paper on "The Mechanical Propulsion of Tramway Cars." Altogether he thought that gas and oil engines promised to be the most successful motors in the near future. While he was not prepared to say that electrical methods were out of the running, he thought, as against the self-contained motor, the overhead trolley system was simply a temporary expedient. With our low fares and repeated stoppages and startings there was, he felt assured, less chance of making the trolley system pay here than in America. This was due to the great waste of energy at the central station, which he demonstrated by diagrams. A discussion followed. It was taken part in by Prof. Jamieson, Mr. Mavor, and Mr. George Johnstone.

Appointment.—There were 43 applicants for the position of electrical engineer to the Shoreditch Vestry. Three were selected, and from these Mr. C. N. Russell, lately with the London and Lancashire Electric and General Engineering Company, has been appointed. He will commence his duties on December 1st.

A Trial Trip of Ward's Electrical Omnibus.—Mr. Ward's excuse for the failure of his electrical omnibus on its trial trip last Friday strikes one as being a very sorry explanation, if the newspaper reports correctly describe his statements; and the further observations of Major Flood Page seem to us to have been of the kind best left unsaid. Mr. Ward is thus reported:—

"It is," he said, "very difficult to maintain proper supervision in the shed where the omnibus is housed, and on three separate occasions during the last 12 hours I have found the electrical connections, which determine the pressure to be put into the motors, changed. When these are first put in they are very complicated, but when the connections are once established and covered up—as they will be in ordinary use—there is a very small chance of their going wrong. In the present omnibus they were uncovered and have been tampered with, the result being that the gear was put out of order, and it was impossible to use the power."

If in half a day the 'bus had been tampered with three times, it shows a lack of watchfulness which will seem to most people perfectly inexcusable. And knowing this, why had not Mr. Ward some spare leads on board, so that in 10 minutes or a quarter of an hour temporary connections could have been readily made by an energetic assistant? One would think that the motor arrangements were simply made up of connections! The maximum speed at which the 'bus covered 100 yards is stated to have been about half a mile an hour; and one paper, with unconscious irony, remarks:—"It is an item of interest for people to know that the accumulators which propelled the omnibus yesterday were equal to 12 horse-power for seven hours"! Then up spoke the chairman of Mr. Ward's company:—

"It must be understood," said the Major, "that we are only in the experimental stage—that we are only trying to find out what is the best thing in electric traction. We do not say that we have got to perfection in electric omnibuses; but even during your short, but unsuccessful, journey round the corner, you must have noticed that the omnibus itself is a welcome thing in its construction, and that if carried out on its arrangement of air-bags, which prevent any vibration, it must be an improvement on present 'bus travelling."

If our memory does not deceive us, the gallant, enthusiastic, and always sanguine Major, when speaking at the meeting of the London Electric Omnibus Company in September, led his hearers to believe that the experimental stage had been passed, and that they knew quite well what he now explains they are trying to find out! We once remember having a new cigarette-maker brought to our notice in a railway carriage, and the delighted purchaser insisted upon showing us how easy and simple a matter the turning out of cigarettes in quantities had become. After many trials without success, he arrived at his own station without having succeeded in producing one finished article, and when getting out he apologised profusely for his clumsiness; "but," he concluded, "you see the idea is a splendid one!"

Oh! Labby, Labby.—The *Glasgow Record* is responsible for the following paragraph:—

A Scottish Triumph.

Mr. Labouchere states that a friend of his, learned in electrical science, asserts that a primary battery has been discovered of such potency that a large ship will be able to go to America with its motive power enclosed in a jam pot. "Labby" says—and this will be specially interesting to readers of the *Daily Record*—that the discovery was accidentally made by two Scotch boys, and has been taken up by several Scotchmen of large means and considerable business experience. The statement gains a certain amount of credence by the introduction of the two boys. No one could find so much motive power in a jam pot as a boy—except two boys.

Who may this friend, "learned in electrical science," be? Surely this cannot refer to a certain Scotch battery tested by "perhaps the largest owner of electrical launches in the kingdom."

Death from Electric Shock.—Claim for Damages.—Three companies—including an electric lighting, a telephone, and a railway company—have been sued for £6,000 odd damages in the States, for the death of Frederick Strassner, who was killed by a live electric wire on Clinton Street, near Third Avenue, New York, on September 19th. The suit, says the *Galignani Messenger*, was brought by the widow and three children.

Looking Back.—A contemporary has a contributor who rejoices in the name of "Meteor." This fireball thus expresses himself on the battery of the brothers McDonald:—"Nearly two years ago I exposed the absurdity of their claim for a primary battery, which, if they were to be believed, involved perpetual motion, or its equivalent. Quite recently our contemporary, the ELECTRICAL REVIEW, has devoted a disproportionate amount of space to the same subject, &c." If "Meteor" will kindly refer to several of our issues for February, 1895, he will probably find that the REVIEW was not far behind, if not, indeed, a little in front, in criticising the cell to which he alludes.

Zinc and Primary Batteries.—The present price of battery zinc in large sheets, we are informed, is £28 per ton. From the formula that the quantity of zinc consumed in each cell of a primary battery per horse-power hour $= \frac{1{\cdot}995}{E}$ lbs., where E is the electromotive force of the whole battery, those people who believe in the McDonald cell can easily work out for themselves the cost of zinc alone at 3d. per lb., and the result will probably be an "eye opener," especially as that consumed in local action has also to be added, at times a by no means inconsiderable percentage.

The "Street Railway Review."—The publishers of the Chicago *Street Railway Review*, whose special numbers we have occasionally referred to, have made arrangements for bringing out quarterly, commencing with January, 1897, a foreign edition of their journal, which will be similar to their American issues, but will circulate among officials of British and Continental street railroads. We wish our contemporary success in its new venture.

Dublin Corporation Summoned.—Messrs. Oetzmann and Co., of Grafton Street, Dublin, have been waiting since January, 1895, for a supply of current from the Corporation. The firm has now sued the Corporation for default, alleging that such default has lasted for 300 days, the penalty for which, under the Board of Trade provisions, shall not exceed 40s. per day. When the case came on at the Dublin Southern Police Court on 19th inst., the Corporation were not ready. On 23rd inst., after short hearing, it was again adjourned.

Nuisance.—A lady residing in Woodhouse Park, Shepherd's Bush, complained at the West London Police Court of noise and annoyance caused by the works of the new electric railway in the course of construction. She was advised to consult a solicitor.

The Royal Society.—Before this Society yesterday afternoon a paper was read by Prof. Fleming, F.R.S., and Prof. Dewar, F.R.S., "On the Magnetic Permeability of Liquid Oxygen and Liquid Air."

The Northern Society of Electrical Engineers.—At the meeting held on Tuesday, November 24th, the discussion on Mr. J. S. Raworth's paper on "Cheap Steam Power" was resumed.

Society of Arts.—On Wednesday evening a paper on "Recent Developments in Mechanical Road Carriages" was read by W. Worby Beaumont, M.Inst.C.E.

NEW COMPANY REGISTERED.

Electrolytic Plating Apparatus Company, Limited (50,146).—Registered November 16th, capital £50,000 in £1 shares, to acquire the benefit of an existing invention relating to the electrical deposition of metals, to enter into an agreement with A. S. Smith and Sons, of Walsall, and T. Deakin, and to carry on the business as platers and metal tube manufacturers. The subscribers (with one share each) are:—A. S. Smith, Tudor Hill House, Sutton Coldfield, manufacturer; T. A. Smith, Highgate Road, Walsall; W. D. Cozens, Pursehouse Street, Walsall, tanner; R. J. Smith, Highgate Road, Walsall, manufacturer; S. Smith, Tudor Hill House, Sutton Coldfield, manufacturer; F. T. Cozens, Hatherton Place, Walsall, tanner; F. Baulis, Highgate Road, Walsall, manager. The number of directors not to be less than three nor more than five; qualification, 500 shares; remuneration, £650 per annum divisible. Registered by Waterlow & Sons, Limited, London Wall, E.C.

CITY NOTES.

The Edison & Swan United Electric Light Company, Limited.

AN extraordinary general meeting of the shareholders was held on Tuesday at Cannon Street Hotel, under the presidency of Mr. J. S. Forbes, for the purpose of passing certain resolutions which have already appeared in the ELECTRICAL REVIEW, having for their object the taking over of the undertaking of the Manchester Edison-Swan Company.

The CHAIRMAN said: I think the notice just read sufficiently explains the object of the meeting. It is, in fact, to amalgamate with what was an off-shoot of this company. This is not a proposal to buy out certain people, or to give them so many sovereigns for their business and their goodwill, and therefore I had better, perhaps, just tell you exactly what the Manchester Edison-Swan Company is. They were licensees of the parent company, formed by a number of Manchester gentlemen for the purpose of exploiting this business in their own area. I will not define too particularly the area, but there was an area, and the bargain was that, in consideration of paying £13,000 at the time to the Edison & Swan Company, with the condition that they should purchase from them all their lamps, they were to trade in their own fashion and on their own account within a limited area. The other parties to the bargain—the Edison & Swan Company—were restrained from themselves trading in that area. That state of things went on for some years. Like ourselves, in the first few years they did not make any very great progress, but they have succeeded in establishing a business within that area for the sale of lamps and lamp fittings, and so forth. They had not been in existence very long before certain questions arose, and by a sort of tacit understanding they claimed the right to do just what they chose, eventually both in their own area and out of it, and we did ditto, and the result was that our own child became a competitor against the parent, and that competition bade fair to damage both companies. If we had pursued it we could have very speedily ruined that company and damaged ourselves, but we thought it a much wiser thing to see how the differences could be adjusted, and whether these gentlemen, having put 30,000 sovereigns of their own into one part of the business, and having become liable to the bankers for £30,000 more, did not think it better to come into the fold rather than quarrel any longer. That is the underlying essence of this proposed agreement which is to be submitted to you to-day. We have had a great deal of correspondence and negotiation. They are extremely clever people, as you know, in Manchester, and the names of the gentlemen on the prospectus of the Manchester Edison Swan Company show the character of the men you have to deal with. They are all gentlemen who have reputations in Manchester. They were wise enough to see that it was better to unite rather than to fight. Of course, they would very much have liked to have taken 30,000 sovereigns and gone out, but we did not see that; therefore, we have gone on the theory of their remaining in and becoming partners with us, and not clearing out and leaving us. The position of the Manchester company is this:—They have got £30,000 in the business. That is the lamp and fitting business—the particular business which we carry on in London and over the rest of the Kingdom—and upon that business they for some time did not do very much. During the last few years, however, they have managed to pay a dividend upon the capital of 5 per cent. They were tempted into the business, not merely of lamps and fittings, but also of electric lighting—that is to say, they generate the current from a central station. These gentlemen have got at Altrincham, which is one of the most populous suburbs in Manchester, a business in this line, at which they seem to have been doing very well. They have spent £30,000 upon it, which they have raised in the shape of loans. This has been going on for two years, and it bids fair to be a business profitable to them and to us, if we take it over. When we first began negotiations, they had increased from 3,000 or 4,000 to 10,000 lamps, and during the last four or five months the 10,000 had increased to 14,000, and we have satisfied ourselves that 14,000 lamps and the future development will make it a paying business. Now they are to bring these into the pot, and instead of taking 30,000 of our sovereigns, they are going to take the money in shares, which is quite another matter That makes them partners, and binds them, as it binds us, to do the best we can for our shareholders. In respect of the £30,000 worth of loans, we have said: "Very well, now you must come in with that too, and you, gentlemen, amongst you interested in this Manchester business, must contract to take £30,000 of our debentures, which we propose to issue." That is the state of the case, so far as the money consideration goes. This agreement, if carried out, will not only make them partners in the common interest, but will also bring in a business which is fairly profitable, and which can be made more profitable. It furthermore relieves us from the dangers of their competition. There was one particular element in it which was rather serious with us. In the original agreement they were authorised to call themselves the Manchester Edison & Swan Company, and we found that a very serious lever, when they came to compete with us outside the Manchester area, all over England, and in London itself, by representing themselves—with perfect legal right—the Edison & Swan Company—our own name and our own mark. That we bring back, and you will be glad to hear that, notwithstanding the ups and downs of this electric lighting business and the serious competition we have had to go through since the patents terminated, our name is a matter of some moment to us even now. It has a market value, and, therefore, to have gentlemen in the market who have the same legal right to use that valuable name as ourselves, was extremely awkward in competition. That is a danger which has been got rid of; in fact, it is the consolidation of two kindred concerns in a common interest with each other instead

of in competition. That alone has approved this step to our minds, as I trust, when you understand it, it will approve itself to yours. Taking their accounts, the bargain we have made is based upon their last balance-sheet. This is the only substantial report which we could lean upon, because it is published by the board, certified by a very creditable firm of chartered accountants in Manchester, and was formally submitted to the meeting, and therefore I suppose it may be taken to be as honest and as fair an account of the doings as we submit to you in our half-yearly or yearly reports. The essence of the report is that upon their several undertakings they made a gross profit of £7,491. These are the profits which they made, and we have gone into them with some care. They have opened their books to us, and they have stood our cross-examination in a way which satisfies us that that really represents a correct statement of their affairs. Of course, these profits were burdened with the general administration expenses, which mop up £5,800 of that £7,491, but even then there was a sufficient profit left to enable them to pay 5 per cent. on their £30,000 capital, and to carry over something. With respect to the £30,000 loans, the interest on that amount is brought in as working expenses, so that it is as broad as it is long. You can now judge as well as we can whether to buy a business of that kind, to get rid of competition of the kind I have described, and to obtain a going concern which appears fairly to pay 5 per cent. in its present stage of development, and which promises to develop much more largely, is not a wise proceeding. We propose to hand them over 10,000 of our £3 paid £5 shares in exchange for their 20,000 £1 10s. paid shares, leaving, of course, these shares saddled with the liability of a call of £2 some day, just the same as our own "A" shares, with which they will rank. With respect to the £30,000 involved in the lighting company, that I have told you we propose that they shall subscribe amongst them and amongst their friends to the first issue of our stock providing, of course, you agree to the wisdom of the scheme. By this means there will be an end to the competition which was becoming a danger to both companies. That is a thing apparently worth achieving, particularly as we shall be left with plenty of other competitors who will have a good many advantages, but not the advantage of describing themselves as the Edison & Swan Company, and having the trade mark of that company to deal with. Then there is the entire consolidation of interests to be considered. Their £30,000 in shares and £30,000 in bonds will be in our pot, and they will have the same interest in the development of the business as we shall. We shall also get back our trade mark and our name, which is immediately, and will be in years hence, of great value. That seems to me to be a summing up of the advantages we shall get out of the transaction, and recommend you, therefore, to confirm the agreement which is devised with the object of bringing this state of things about. Both boards are satisfied that in recommending their respective shareholders to agree to it, they are recommending the thing which is in the best interests of all. He then moved the resolutions in the terms set forth in the ELECTRICAL REVIEW of last week.

Lord LICHFIELD seconded the resolutions, which were put and unanimously agreed to.

Brockie-Pell Arc Lamp Company, Limited.

THE statutory general meeting of this company was held on Tuesday, at 97, Queen Victoria Street, E.C., under the presidency of Lord Suffield.

The CHAIRMAN said: You are aware of the nature of this meeting, I have no doubt, and therefore I need not trouble you with any explanations with regard to it. It is, as you know, practically a formal meeting, and is called in pursuance of an Act of Parliament, which necessitates the holding of a meeting within four months of the registration of a company. But I dare say you will be interested to know a few things with regard to the business in which you are interested. The company went to allotment on August 4th last, and before doing this the directors were careful to see that the full working capital, as stated in the prospectus, was secured. That is one of the first steps, and one of the most necessary. The next thing is that we instructed the company's solicitors to prepare all necessary documents for the assignment of the patents to the company; these have been completed, and the patents are now vested in the company. The directors then set to work with the one view before them of manufacturing the lamps under these patents. Our engineer, Mr. Brockie, has designed special appliances and machinery which will ensure the rapid and accurate production of a better article than has hitherto been supplied to the public; our intention is—and this I draw your attention to, because I think it is a very important matter—to adopt the strictly interchangeable system in every part in the lamps of our make. That, as I dare say many of you will see, is a very desirable thing to have done. All arrangements are being pushed on as rapidly as possible, and some of the machinery has already been delivered, while the remainder is now in transit to us. I believe that since I received the last report a considerable portion of that machinery has already arrived. The directors have secured suitable manufacturing premises in Finsbury, and as the demand for the lamps is increasing, and the outlook for the future business very promising, they have, in taking these premises, borne in mind the probable extension of the company's trade. Mr. Brockie and Mr. Pell have become permanently associated with the company, and are giving their careful and constant attention to the many details incidental to the company's business. I can assure you, from my personal knowledge, that those gentlemen may be said to be working night and day; that is to say, they work every day and all day, and give as much attention to the business as any gentlemen could possibly give, and I do not think we could be in better hands. We are taking into consideration the question of dealing with the foreign patents of the company, which we think should prove a valuable asset. It remains a question which we shall keep, and which we shall dispose of, but I think if you will kindly leave the matter in our hands, we will do our best for the proprietors. We are glad, and I am especially glad, for this opportunity which is afforded us to-day of meeting you, and we have a confident hope of being enabled to offer you satisfactory information as to the progress of the company before very long. That is a very brief statement, but really it is all that is now required. You know very well what a short time it is since we started, if we may be said to have even started now; but we are using every endeavour to further the business of the company. It is not one of the easiest things to carry out the details of, or start such a company as this, but you may take it from me that we are doing everything we can to satisfactorily start the undertaking, and you may also rest assured that I and my colleagues are fully of opinion that your property is an extremely good one. If any proprietor has anything to say, or any question to ask, by all means let him ask it, but I have already said that we are really only just commencing the business, and if you will wait till a later occasion, I hope, as I said before, that we shall be able to give you a very satisfactory account of our affairs.

A SHAREHOLDER: Might I ask whether you have taken any steps to obtain a quotation on the Stock Exchange for these shares?

The CHAIRMAN: No, sir; I believe not at present. I do not suppose we are in a position to obtain a quotation.

The SOLICITOR (Mr. Crisp): The vendors' shares are too large a proportion; they amount to more than one-third of the capital.

Mr. BAILEY: May I ask the amount of contracts in hand at the present time?

Mr. BENNETT PELL: Yes, I will answer that. There are several contracts in hand, some being very important ones. I will mention the principal ones being carried out at present. Taking the places abroad first, there is the city of Durban, the capital of Natal; then another is being carried out at Johannesburg at the present moment. We have recently sent out a large number of lamps to a well-known mining company, the Mount Morgan, in Queensland, and several have been supplied to mines in South Africa. I cannot recollect any particular ones just now; but a very large number have been supplied in one way and another abroad. At home, I may tell you, there is a contract for lighting the streets of Chester, and there is a contract for an extension of lighting in South Shields, and another one for an extension of lighting in Taunton. Then in London there is one being carried out in a large district in the West End, Hammersmith, and the upper part of Regent Street, a great many of you may have noticed, has been recently lighted with our lamps; in fact, it was only completed last week. Then there is a large district in the East End, Shoreditch, where they are using our lamps exclusively. Other contracts are under consideration at the present moment. Of course, there are a large number of lamps besides which have been supplied to various people. We have recently been delivering lamps to some of the railway and dock companies, and altogether I think the business is very satisfactory.

A SHAREHOLDER: Is it understood there can be no quotation on the Stock Exchange?

The SOLICITOR: We will put the matter before the Committee.

A vote of thanks was moved to the chairman for presiding. This was seconded and carried, and the meeting closed.

Stock Exchange Notices.—The Stock Exchange Committee have appointed special settling days as under:—Wednesday, December 2nd, Electrical Development and Finance Corporation, Limited—10,227 shares, Nos. 1 to 10,227; Thursday, December 3rd, Milwaukee Electric Railway and Light Company—$5,500,000 5 per cent., 30-year consolidated mortgage gold bonds of 1926, Nos. 1 to 5,500, and ordered the latter securities to be quoted in the Official List.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended September 30th last, and payable on December 18th. The transfer books of this company will be closed from December 11th to 17th, both days inclusive.

Eastern and South African Telegraph Company, Limited.—The numbers are published of the 5 per cent mortgage debentures, drawn for payment at par, on January 1st, 1897, at Barclay's bank.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 22nd, 1896, were £1,017; week ending November 24th, 1895, £946; increase, £71; total receipts for half-year, 1896, £19,842; corresponding period, 1895, £18,562; increase, £1,280.

The Liverpool Overhead Railway Company. The receipts for the week ending November 22nd, 1896, amounted to £1,183; corresponding week last year, £1,067; increase, £116.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 20th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,720.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Nov. 18th.	Closing Quotation, Nov. 25th.	Business done during week ended Nov. 25th, 1896. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	51 — 54	51 — 54	54	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	96 — 97	96 — 97	97	95⅞
2,993,560£	Do. do. Defd.	Stock	...	...	...	10 — 10½	10 — 10½	10 5/16	10 1/16
130,000	Brazilian Submarine Teleg., Ltd.	10	6½%	7 %	7 %	14⅝— 15½	14⅝— 15½	15 5/16	14⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	...	2½%	4 %	3¼— 3⅜	3¼— 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	157 —162	157 —162	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 %	1½%	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	11½ - 12½	11½ - 12½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ - 19½	18½ - 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ - 4½	3½ - 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
80,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110 %	107 —110%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝%	2 %	2¼%	9¼ - 9⅜	9¼— 9⅜	9 7/16	9 5/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17¼ - 17⅜	17 — 17¼	17 7/16	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6 %	6	17½ - 18½	17½— 18½	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	105 —108	104 —107	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —129	126 —129	128½	126½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17¼ - 17⅜	17 — 17½	17½	17
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	129 —132	128 —131	129½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	108½	107
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	108 —111 %	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝%	4½%	4½%	11 — 11½	10¾— 11¼	11 3/16	10⅞
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	17¼— 17⅜	17 — 17½	17 5/16	17⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	24 — 25	24 — 25	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 55	53 — 56	56½	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5 %	5½%	7⅛— 7⅜	7 — 7⅛	7⅛	7
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	17 11/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅝— 6⅞	6⅝— 6⅞	6 13/16	6⅝
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —108	105 —108	105½	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	5 %	11/16— 13/16	11/16— 13/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3½— 3⅝	3½— 3⅝	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	5 — 6	5 — 6	...	...
238,360£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	½ - 1½	½ - 1½	...	...
150,060£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	95 —101	96 —101	95	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	7⅞— 8¼	7½— 8	8	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6⅝— 6⅞	...	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	1⅞— 2⅛	1½— 2	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	1⅝%	1⅝%	7⅛%	1⅜ - 1⅝	1⅜ - 1⅝	1 9/16	1⅜
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11⅝ - 12¼	11⅝ - 12¼	12⅛	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ - 10½	9½ - 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	107 —112	107 —112	110½	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9½— 10	9½— 10	9½	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅞— 8¼	7⅞— 8¼	8⅛	8
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —117	114 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	16 — 17	15½ - 16½	17	16 1/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17⅛	16½— 17½	17½	17
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	130 —135	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	...	*nil*	8 — 9	8 — 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13⅜— 14½	13⅜— 14½	...	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	7½— 8½	7½— 8½	8½	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13 — 14xd	13 — 14	13⅜	13 3/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	6½— 7	6½— 7	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	121 —124	121 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	9½— 10½	9½— 10½	10½	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12 — 13	12 — 13	12⅝	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅝	10½
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	10½— 11½	10½— 11½	11	10⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless therwise stated all shares are fully paid. ‖ Dividends paid in deferred share warran profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years.			Closing Quotation, Nov. 18th.	Closing Quotation Nov. 25th.	Business done during week ended Nov. 25th, 1896.	
			1893.	1894.	1895.			Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 % §	2½%	...	⅞ — 1⅛	⅞ — 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1 — 1¼	1 — 1¼	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	96 — 100	96 —100	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	9¾— 10½	10⅛	10
207,649	Do. do. do. £4 paid	10	...	...	...	4 — 4¼	4 — 4¼	3⅞	...
630,000£	City and South London Railway	Stock	1⅛%	1⅛%	1 1/16%	52 — 54	52 — 54	54	52⅜
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	*nil*	2 — 2½	1⅞— 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅞— 2¼	1⅞— 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	106	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1½— 1⅝	1½— 1⅝	1⅝	1½
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½— 3	2½— 3	2⅞	2⅝
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾— ⅞	¾— ⅞	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	½— ¾	½— ¾	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½— 11½	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17 — 18	17 — 18	17½	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	20½— 21½	20½— 21½	21	20½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13⅜— 13½	13⅜— 13½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅞— 17⅜	16⅞— 17⅜	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	39 — 42	39 — 42	41	40
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	7⅜— 8¼	7⅜— 8¼	8¼	8

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 8, £5 (fully paid) 9¼.
Electric Construction Corporation, 6 % Debentures, 104—106.
House-to-House Company (£5 paid), 4¼—4⅝.
Do. do. 7 % Preference, of £5, 8½—9.
Do. do. 4½% Debentures of £100 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10—10½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅜.
London Electric Supply Corporation, £5 Ordinary, 1—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

* From Birmingham Share List.

Bank rate of discount, 4 per cent. (October 22nd, 1896).

BALATA INDUSTRY OF DUTCH GUIANA.*

Her Majesty's Consul at Paramaribo, in a report upon the balata industry of Dutch Guiana, says that the collection of the milk of the bullet tree there is an industry of quite recent creation, and as such was originated by British capital. The bush negroes were in the habit of drinking the milk of the bullet tree, and mixing it with their chocolate. They are well aware of the injurious effect of taking spirits immediately after having drunk bullet tree milk. According to the Government Botanist and Superintendent of the Botanical Gardens, British Guiana, the bullet or bully tree, *Mimusops Balota*, from the bark of which balata is obtained, is a large forest tree, belonging to the order *Sapotaceæ*. It reaches maturity at a height of 120 feet, with usually a large spreading head, and a trunk 60 to 70 feet long and 4 to 5 feet in diameter. According to another authority, who has had very extensive personal experience of balata collecting in Netherlands Guiana, the tree is found in the Netherlands Corsutyne Border in great abundance in the low-lying zone of fluvio-marine deposit. It is also found in the higher lands of the interior, but in a less abundant and more scattered condition. On the bullet tree bearing grounds in forests where they are plentiful, the observer may see from 20 to 30 trees of a thickness of 12 to 30 inches, within a radius of 100 feet around him; where the tree is less plentiful, the observer will only see two or three trees within the same area. The bleeder usually looks over his head, and discovers the tree by its foliage. He also knows that the bullet tree must be near when he comes upon certain kinds of bush. Above a trunk, the thickness of about 30 inches, the tree is usually not worth bleeding. In comparison with the rubber tree on the Amazon, the distribution of the bullet tree in Dutch Guiana is much more limited. Dr. Hugo Müller, speaking of the commercial character of balata, says: "It commands a higher price than gutta-percha, and that in itself is a proof of its usefulness. It is used almost in all cases in which gutta percha is used, but on account of its higher price, only for superior purposes. It seems that balata is treated by the manufacturers simply as a superior kind of gutta percha, and therefore its name disappears when manufactured, nevertheless balata is distinctly different from gutta percha, and this is especially manifested in some of its physical characters; for instance, it is somewhat softer at ordinary temperature and not so rigid in the cold. The chemical composition, however, is probably quite identical with that of gutta-percha and caoutchouc. In one respect balata shows a very marked and important difference from gutta percha, and that is in its behaviour under the influence of the atmosphere, whilst gutta percha when exposed to light and air, soon becomes altered on the surface and changed into a brittle resinous substance, into which the whole of the mass is gradually converted; balata, on the other hand, is but slowly acted upon under these circumstances." The balata industry in Dutch Guiana is in its infancy. In Surinam the forests which have been bled are abandoned, and new lands are sought for and exploited. Only those areas where an abundance of trees is to be found have been selected. On areas where 100 trees are found, it sometimes happens that about 75 per cent. only will give milk at the particular period when the bleeder visits them, and that at some later period the remaining trees will also run, but as the bleeders have gone beyond that particular section, it is not profitable to come back and bleed the remaining trees just at the special time when they are ripe for it. There seems to be little doubt that there is yet considerable room for the further development of the balata industry in Surinam. The future of the industry is, however, fraught with greater risks, as more remote districts have to be explored and opened up. These lands are situated higher up the rivers, and the expenses of reaching and keeping up communication with them is considerably increased by reason of the presence of falls and obstructions to the navigation of the main fluvial arteries of this colony in their higher reaches. On the Maroni river, a few Para rubber trees have been met with, but to a very limited extent. It is hardly possible that the balata bleeders, who are well acquainted with the *Forsteronia gracilis* and *Hevea*, should not collect this milk if they found the trees in such numbers as to make it worth their while tapping them. Enquiries for various collections tend to show that though various other milk-giving trees are met with, their number is too limited to make it profitable to bleed them. The forests are all the property of the Crown, and are leased by the Colonial Government at a rental of 10c. (1d.) per hectare (2·47 acres) per annum, for the exploitation of balata only, and that in conformity with the Balata ordinance of the colony. The bleeder receives advances from his employers against which he contracts to deliver balata. For his balata he receives about elevenpence per pound. A very successful bleeder will get as much as ten gallons a day. A gallon of milk will dry to about four pounds of balata. The bleeders are mostly recruited from Berbici, in British Guiana, and about 1,000 men are at present employed in Dutch Guiana in the industry. The very hot and very wet seasons are not good for balata bleeding. The trees blossom in August and the seed drops about the month of November, when the new leaf shoots out. By the end of January the milk obtains the condition when it runs most plentifully. The leaves of the old trees, the milk of which is not easily obtainable, are dark brown on the lower side and green above; the younger trees are light green on both sides. During the flowering season the milk does not flow to any paying extent. The leaves of the young trees are thick, and when broken the milk issues freely from the wounds. After the month of August to the middle of January no work is

* *Journal of the Society of Arts.*

done, this leaves about eight working months. As regards the progress of the balata industry, it appears from statistical returns that the quantity of balata exported amounted to 108,286 kilogrammes (kilogramme = 2·204 lbs. avoirdupois) in 1894, and 133,681 kilogrammes in 1895. The values were respectively £216,573 and £267,362. During the year 1895, 335,484 hectares of land were granted by the Government for the exploitation of the balata industry.

APPLIED ELECTRO-CHEMISTRY.

By JAMES SWINBURNE.

Cantor Lecture IV.—Delivered before the Society of Arts, May 18th, 1896.

Electrolytic Caustic and Bleach.

Inventors are still devoting their attention to curious vats and queer diaphragms. In some ways it seems as if too much attention has been given to electrolytic alkali. The alkali business is so enormous that it is a great temptation to inventors, but on the other hand the products are low priced, and therefore there is not so much margin. It does not seem to be quite well enough understood that electrolytic alkali is not waiting for some wonderful vat. The processes already in use are quite good enough to give enormous profits if worked economically, but careful supervision is necessary, and great attention to detail. Unfortunately such processes generally get into the hands of limited companies, and limited company management is seldom conducive to success in such cases. It must also be borne in mind that the cost of the electrolysis itself is a small portion of the cost of making electrolytic caustic and bleaching powder. So small a portion of the cost is it, that a great improvement in the vats would make very little difference in the price of the finished material. Unfortunately everyone wants to have a vat or system of his own invention. A manufacturer who started up with the determination to use no apparatus which was patented, or called after anybody, would have a much better chance of success, especially if he employed a few sharp young chemists to watch the vats, make tests, and find out the very best conditions for working. Generally the various inventions consist of varieties of porous diaphragm. Of course, an arrangement like that of using mercury as an anode and cathode in one is a different matter. This gives pure caustic, as there is no chlorine in the cathode chamber. If no hydrogen is given off at the surface of the mercury in the anode compartment, the current efficiency must be unity. Having no salt in the caustic means considerable economy in finishing.

Some injustice has been done to this process by those who have raised the cry that the mercury is poisonous. There can be no danger whatever in such a case. I have had charge of lamp works where mercury is used in the exhausting rooms, where it seems to be ubiquitous. Yet all that is needed is to keep the mercury clean, so that it does not flour or powder. When a glass pump breaks, the mercury gets all over the linoleum covered floor, and is merely swept up. In spite of this, I have, in several years, never had the slightest case of salivation. When the mercury is permanently under liquid, as in the alkali process, it is quite absurd to suggest danger to the health of the workmen.

One of the difficulties in making bleach is that the anodes are attacked, and a proportion of carbon dioxide is given off with the chlorine. This converts some of the lime into chalk, and lowers the possible percentage of available chlorine. I have found—at least on a small scale—that this difficulty can be overcome by letting the chlorine and carbon dioxide first pass over some bleaching powder, which takes up the dioxide, giving off chlorine instead. When it is converted into chalk, it is thrown away. It would be useless to burn it into line, as it contains chlorine as well as carbonate. By this means good bleach can be made. It seemed possible that the carbon dioxide would evolve hypochlorous anhydride, which would be taken up by the lime, giving bleaching powder with a higher percentage of available chlorine than usual. It is doubtful if such a reaction takes place, and still more doubtful if it could be worked on a large scale. Mr. Charles Waite was, however, before me in working out this scheme, and it has been in operation at the Rumford Falls Electrochemical Works for some time now.

Recently Dr. Hurter has urged that it is impossible to get strong caustic in an ordinary vat at a high current efficiency. I do not understand Dr. Hurter's reasoning, and so I may quite unintentionally misrepresent his views. At a discussion on Mr. Hargreaves's paper, at the Society of Chemical Industry, where I first heard Dr. Hurter's views, I suggested that he was confusing the carriage of the charges by the ions with the liberation of the final products at the electrodes. I have not seen the printed account of this meeting yet, so do not follow Dr. Hurter; but he kindly sent me a paper read by him at the Liverpool Physical Society in 1893. Unfortunately I cannot follow this either; but as far as I can make out, Dr Hurter thinks that in a solution containing salt and caustic the current is carried partly by the hydroxyl ions and partly by the sodium and chlorine ions, with which I agree, and that the portion carried by the hydroxyl, or by the hydroxyl and some of the sodium ions is useless, because it does not make more caustic, with which I disagree entirely. As long as there is available chloride in the immediate neighbourhood of the anode, chlorine, and not oxygen, will be evolved. At the cathode, again, hydrogen must be evolved. This being the case, either caustic and chlorine are made, or caustic gets at the anode and takes up the chlorine, making hypochlorite, and perhaps chlorate.

Again, if hypochlorites or chlorate get to the cathode, they will be reduced wastefully. But these are conditions that would not occur in a rationally conducted works. If you put salt into a vat, and stir it round during the electrolysis, the result will obviously be that very soon hypochlorite will be formed in large proportions at the anode, to be reduced again at the cathode. But then nobody tries to make soda and chlorine that way. Suppose, however, that the liquid is still, and there is a porous partition. Start with all chloride. Chlorine comes off at the anode, and hydrogen at the cathode, and caustic appears at the cathode. We now have, in the anode compartment, chlorine moving towards the anode, and sodium towards the cathode. In the immediate neighbourhood of the cathode we have both caustic and chloride. We thus have the current there borne by the sodium moving towards the cathode, and also by hydroxyl ions moving towards the anode, and chlorine ions moving towards the anode. Eventually the hydroxyl ions will reach the porous partition, and they will finally go on into the anode chamber, and we shall there have caustic, which will take up chlorine and make hypochlorite. This, I take it, is Dr. Hurter's difficulty. If the current were borne entirely by the sodium and chlorine, all the chlorine would eventually move into the anode chamber, and all the sodium would move into the cathode compartment. In practice, however, we have to run brine into the vats continuously, and run off caustic solution. The ionisation of the caustic and salt depend on the strength of the solution with regard to both. I need not take actual figures, as it will serve my purpose to suppose for the moment that all the current is borne by the hydroxyl, the chlorine and both lots of sodium ions being idle and not migrating at all. Of course, in the anode chamber, where I assume no caustic for the moment, the current must be borne by the chlorine. Then we have a sort of army of hydroxyl ions marching from the cathode towards the anode at a certain rate. We admit the brine to the anode compartment, and we draw off caustic liquor from the cathode chamber. Then all we have to do is to feed the brine at such a rate that the whole of the liquid moves at the migration velocity of the hydroxyl. The hydroxyl then really stands still, and never gets to the anode. What is drawn off is really a mixture of salt and caustic. The vat has full efficiency, as hydrogen comes off at the cathode and chlorine at the anode. The current being borne by the hydroxyl makes no difference in the current efficiency of the vat, as the current borne by the hydroxyl is just as effective as that borne by the sodium or chlorine ions. The real difference is in the amount of salt it is necessary to draw off with the caustic. If the current were all borne by the chlorine, we could get pure caustic solution off. The relative ionisation of the salt and caustic affect the proportion of salt and caustic drawn off, and thus influence the cost of finishing; but they do not affect the current efficiency. I hope I have not misrepresented Dr. Hurter in any way.

In the case of making chlorate, all that is necessary is to feed the potassium chloride in at the cathode end, and draw off the chlorate at the anode. The same vat gives either product, according to the direction of the fluid current. Of course the chlorate vat must be hot, and as the anode liquid is not acid, platinum anodes are available. I tried small chlorate vats on this principle some years ago, but have made very few and imperfect experiments on caustic soda.

Copper Refining.

There is but little to be said about copper refining or the electrolytic extraction of the metal from its ores. A great deal has been published about refining, and still more about various schemes for extraction, and there would be little use in repeating such accounts here. At the same time, there is a great deal—as Badt points out—that is not published. Copper refiners seem to think they are working a magic secret process, and that if they keep all the details to themselves no others will be able to compete with them. Such ideas are commonly to be found among workmen, but are seldom encountered among educated people; and the probability is that the various copper refiners are working their processes as badly as they can be worked, and understand very little about electrolytic work. The unfathomable secret guarded by copper refiners seems to be the use of anodes and cathodes of copper in a solution of copper sulphate. As regards details of management or of processes, such as the best temperature to work at, or the best method of circulating the liquid, there can be very little to learn. It would be much better, however, for electrolytic copper refiners to publish results and compare notes, as if they are competing with one another, any knowledge, shared equally among them, makes no difference, but it puts them all in a better position as competitors in the race with refiners who use ordinary metallurgical methods. The same sort of thing went on in early days among incandescent lamp makers, and, in fact, it still goes on. Fortunately, workmen are migratory, and wandered from factory to factory, so that each factory knew what the others were doing, but thought its own processes were profound and valuable secrets. The more insignificant the works, and the more idiotic the process, the greater was the secrecy observed.

The main difference between two classes of copper refining processes consists in the series or parallel coupling of the plates. From a purely electrical point of view, this looks like a distinction without a difference, but there is more in it than appears at first sight. It makes little difference in the energy used per ton of copper refined, the only source of divergence being the numerous contacts in the parallel system. When a vat only takes a fraction of a volt, a large proportion of the power may be wasted on imperfect contacts.

The series arrangement, however, saves a good deal of money in the leads, and greatly simplifies the connections. It is often supposed to have some magic efficacy in giving a greater output of copper for a given power, but that is absurd. Its great advantage really lies in its needing less copper in the vats for a given output. This may seem a small matter, but if prices are worked out it may mean a very important saving. Take an example. Suppose copper is deposited at, say, 5 amperes per square foot; and suppose the anodes are cast,

say three-quarters of an inch thick, and are eaten off both sides. Roughly, the anodes will take two months to be deposited on the cathodes. Take the case of a refinery dealing with 1,000 tons of copper per month. This means that 2,000 tons are in the vats. As a matter of fact there will be a little more, but we can take 2,000 tons as a good round figure. The value of this copper at £60 per ton is £120,000. Now, the question is what value is capital to the owners of the refinery. They might, perhaps, be able to borrow money, partly on the security of the copper at a low interest; but it is more likely that money is worth 6 per cent. to them, or in other words that their works give 6 per cent. on the capital sunk, and would give at least that interest on any further money sunk safely in enlargement. The interest on the copper in the vats is thus £7,200 a year, or £600 a month. As the output is 1,000 tons a month, this means that the price of refining copper is increased no less than 12s. a ton for interest on the metal in the vats. It is then of great importance to keep down the amount of copper going through the works, that is to say, to make it go through quicker. A little can be done by removing the cathodes when they are $\frac{5}{8}$ths of an inch thick, instead of $\frac{3}{4}$, and putting new ones. This reduces the 12s., not to 6s., but to something above 9s., how much above 9s. depends on the cost of the initial cathodes. Many people may say there are such quantities of copper all about a copper refinery that it makes no real difference whether it is in the vats or in the stores. This argument is fallacious, for the copper in the vats is not available to fill orders, like the finished copper in the stores. The stock of crude copper is merely a kind of buffer or regulator to take up the variations in supply, and give a constant feed to the refinery; the stock of finished copper is to enable a slow and steady production to cope with sudden and irregular demands. The copper in the vats cannot act in either way, and is quite independent of the stocks held, and it cannot be drawn upon. It therefore represents capital lying idle. It is still an open question whether the series arrangement, as series arrangement, saves money. At the Bridgeport Works in Connecticut, which are, I think, the largest electrolytic copper refining concern in the United States, the system worked out by Hayden is used. The anodes are rolled and are quite thin. I forget the dimensions just now, but think they were about $\frac{1}{2}$th of an inch when I saw them. They were arranged in wooden vats taking something like 120 volts, connection being made to one at one end, and to a special cathode at the other. Each of the intermediate plates then becomes both cathode and anode, as one side of it is eaten away, while the other has copper deposited on it. As the plates are rolled they are eaten and deposited very evenly, and the process is carried on till very nearly the whole of the copper is transferred. As the deposited copper never sticks tight to the plates, the remains of the original anodes can be picked off the refined copper. There is, of course, a certain amount of scrap anode which has to be re-melted and rolled again, but as no leads have to be connected to the anodes, and as they are finally supported by the deposited copper, they can be consumed much more completely than in the case of thick cast anodes. The saving is thus essentially in the use of thinner plates, and in the cost of doing away with the necessity for making electrical connection to each plate with its attendant loss of power, due to inferior contacts. The saving in leads about the vat house is also considerable. The most important of these points is, undoubtedly, the thinness of the plates in the vats. There seems no reason, however, why equally thin plates should not be used in the parallel system. There is no reason why the parallel system should be tied down to cast anodes, which must be fairly thick to allow of casting. It might be possible to cast the anodes thinner by adding a little extra silver. I have heard that a very little silver allows copper to be cast well, but do not know if that is correct. The silver would practically all come out again in the refining. Whether a trace of aluminium would do is another matter. It would, of course, be lost, and would gradually accumulate in the bath. These are merely crude suggestions. The series arrangement has been worked out, no doubt independently, by Smith, Hayden, and Stalmann. Who invented it, I do not know. It is described in a pamphlet by Hugon, dated 1885, but I do not know that any copy came into England or America until several years later. Hugon discusses the question of economy of capital sunk in copper going through the process; in fact, it is his main point, and he makes out that the series arrangement is cheaper, but it is difficult to see why, unless the series arrangement alone allows thin anodes and cathodes to be used. Hugon also discusses the use of cuprous chloride. Cuprous chloride gives twice as much copper as cupric sulphate with a given current; but that is not everything, and unless the resistance of the vat is so low that twice the pressure is not necessary, this does not pay. It might be said that a specially low current density might be used, but that means sunk capital again. I do not know at all how far the chloride would do, as it might carry over impurities that remain in the slimes in a sulphate solution. Copper nitrate gives good deposits of copper with enormous current densities, but it is probable that silver and, perhaps, gold are carried over. Swan has made numerous experiments on rapid deposition from the nitrate, but has, I think, published nothing as to its use in refining argentiferous copper. The presence of a very little chloride might prevent silver coming over, but it would hardly stop gold.

Stalmann, who was for some time manager, and who designed the Anaconda electrolytic copper refining works, uses a very ingenious series arrangement. Each plate has paper stuck to one side. A few copper rivets are put through, and the paper is blackleaded. This gives a paper cathode, which separates the deposited copper from the crude, and gives no trouble in separating the scrap anodes from the good deposited cathodes.

It is often supposed that everything electrolytic is pure. Unfortunately, this is not necessarily the case. Electrolytic copper is nearly pure, but it is generally, if not always, contaminated with antimony. It is probable this small trace of antimony does harm, as it most likely reduces the conductivity appreciably, and may alter the non-electrical physical properties of the metal. Antimony can be separated from copper by electrolytic analysis. What is wanted is a method which is possible on a commercial scale.

(To be continued.)

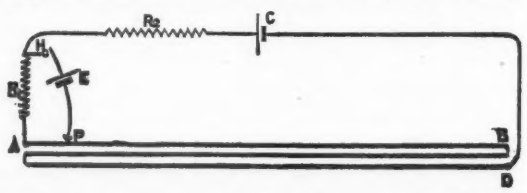
VARIATIONS IN THE ELECTROMOTIVE FORCE OF CLARK CELLS WITH TEMPERATURE.*

By W. E. AYRTON, F.R.S., and W. R. COOPER, M.A., B.Sc.

After a series of preliminary experiments for the purpose of exact measurements three cells were used as a standard, and were placed in boiling tubes fixed in a water bath, the latter being surrounded by an outer vessel into which ice could be packed. As the ice melted the water was carried off by a tube so that it stood at a level slightly above the bottom of the inner case. The whole was surrounded by cotton wool in a wooden bath. By filling the outer bath with ice every evening it was found possible to maintain the temperature of the inner bath fairly constant throughout the following day, the variation rarely exceeding two or three-tenths of a degree in the hottest weather.

In order to check any variation of the standard through causes other than temperature, it was frequently balanced against the P.D. due to a known current of about $\frac{1}{2}$ ampere passing through a known resistance of about 3 ohms. The latter was made especially for the purpose, of manganin wire, wound upon an ebonite frame and immersed in paraffin oil. It was previously aged by heating for five hours at 140° C., and it assumed a steady value after two or three weeks, as shown by frequent comparisons with standard manganin coils. The current was measured by a Kelvin centiampere balance, the constant of which had frequently been checked by means of a silver voltameter. By this means a variation of 0·00015 volt could be detected without difficulty.

A stretched wire, A, B, D, 3 metres in length, was employed in comparing cells under test. The resistance of this being known, the



strength of current necessary to give a drop of potential of one ten-thousandth of a volt per half centimetre length was calculated, and also the resistance required when traversed by this current to balance one of the standards whose E.M.F. was known. The resistance, B_1, was adjusted so as to be as nearly up to this value as possible, and the deficit was found in terms of a length, A, P, of the stretched wire. For example, suppose the resistance necessary to balance the E.M.F. of the standard cell, E, was found by calculation to be 107·15 ohms. Plugs would be taken out of the box, B_1, to the value of 107 ohms, and the point, P, on the wire would be selected such that A, P equalled 0·15 ohm. The current through the wire supplied by a storage cell, C, was then adjusted by the auxiliary resistance, B_2, until the standard, E, was balanced between the points H and P, or so nearly balanced that no appreciable error would result. In this way the wire was rendered direct reading for any subsequent comparisons, $\frac{1}{2}$ cm. on the scale corresponding with one ten-thousandth of a volt. A mercury cup was attached to the terminal of B_1; it was therefore possible to join E with the end of B_1 by simply dipping a wire into the mercury. Thus, any change of resistance in the main circuit by different pressure of the terminal, &c., was eliminated, and the value of the current could be readily checked at any time without interrupting the main circuit. This was done at frequent intervals throughout every experiment. As a rule, very little variation was found to take place. The value of the E.M.F. of the standard cell was, of course, previously known by an absolute determination.

The cells under test were always connected with the point, B, of the wire (1 metre from A), and were balanced against the standard with never less than 10,000 ohms in series. The cells were placed in a water bath, having room for five; the positive poles were joined to a common terminal, the negatives being led to separate mercury cups. Two stirrers were provided for keeping the temperature of the water uniform. There was also an outer bath containing the bath just mentioned. This outer one was heated when required by passing steam through a piece of tubing immersed, and cooled when necessary by means of ice.

The temperature of a set of cells was generally varied through a considerable range, and brought back to practically the same value as it had at the beginning of the experiment. Supposing no lag to exist, the curve connecting temperature and E.M.F. would be the same for both rising and falling temperature. But if there is a lag of short duration (*i.e.*, not cumulative), then, provided that the temperature varies at the same rate throughout, two distinct curves, parallel to the first for the greater part of their length, will result, and will enclose an area between them.

Further, if there is any *semi-permanent lag*, cumulative in its character, a form of curve would result in which the up and down

* Abstract from the *Proceedings* of the Royal Society, Vol. lix.

curves are parallel to one another, but inclined to the true direction.

Any lag of the ordinary kind will soon pass off after a steady temperature is reached, or after the temperature gradient is reversed. But any lag of a semi-permanent character will prevent the curve from returning to its starting point until after the lapse of a considerable time, and will thus produce a break.

In order to investigate the matter, several cells were subjected to cycles of temperature. It was noticed that the parts of an E.M.F. difference curve relating to rising and falling temperature were seldom parallel. It might be urged that this is due to residual changes of temperature making themselves felt on the return curve. But all the experiments tended to show that lag (excluding semi-permanent lag) for this rate of variation of temperature does not, as a rule, exceed a quarter of an hour. The curves at either end would be affected in this manner for a length corresponding with about one degree (the rate of variation being about one degree every quarter of an hour), Beyond that errors might arise amounting to one, or two, ten-thousandths of a volt, due to semi-permanent lag, but they would be insufficient to change the general character of the curves.

The curves indicated that the lag has generally a different value for rising and falling temperature. Certain curves were obtained by lowering the temperature about 9·5°, and then raising it through the same range, but somewhat more rapidly. The lag was found to be smaller for a rising temperature in the case of three of the cells, and two others were practically neutral in this respect, although all the cells were in the same bath.

Curves obtained by lowering the temperature about 10·5°, and raising it again at the rate of one degree every quarter of an hour, gave with three cells a smaller lag with a falling than with a rising temperature, whereas there was very little difference in the case of two other cells. Inequality of lag for rising and falling temperature, in fact, appeared to vary from cell to cell, and even to vary largely in any one cell. The following table gives the results in a manner more easy for comparison (the capital letters being the experimental number of the cells) :—

Conditions of experiment.	Lag smaller for rising temperature.	Neutral.	Lag smaller for falling temperature.
Fall and rise through 9·5° ...	B, L (slight), M	G, N	
„ „ 10·5° ...	...	C, X	F, W, Z
„ „ 10·0° ...	J	F	W, Z
Rise and fall through 8·5° ..	B, F (slight), L(slight), W (?)	Z	
„ „ 2·0° ..	F, L	W, Z	

It was also observed that the curves between temperature and E.M.F. were seldom closed, even though readings were continued for some time after the former assumed a steady value. At the end of any experiment the cells became practically steady after about 20 minutes, and would then readily follow any subsequent variations. One hour and a half is generally quite insufficient to remove the semi-permanent lag, indeed, it was sometimes found not to have completely disappeared by the next morning. In extent it seems to vary considerably, even in the same cell.

In order to observe whether lag existed with slow variations, an experiment was carried out, during which a change of about 2° up and down took place at the rate of 1° in 50 minutes.

The curves are very similar to those obtained in the case of the larger variations of temperature and time. Lag was still evident, though of course much diminished. Two cells showed practically no lag of a semi-permanent character, but it was strongly marked in the case of two others, although a steady temperature had been maintained for some time at the end of the expsriment.

It might be supposed that part of the lag observed was really due to lag in the thermometers themselves. But on subjecting these to cyclical changes of temperature this was found not to be the case.

In general, it thus appeared that Clark cells of this type are very sensitive to changes of temperature, but are subject to a lag, which is variable in value, even when these changes of temperature are small. For that reason it is generally impossible to apply a correction which shall be accurate to 1/10,000th of a volt for even very slow variations of temperature. Of course, in work involving a knowledge of the absolute E.M.F. of the cell, this is of no great importance, as we do not know the value of the E.M.F. to greater accuracy than 0·1 per cent. in true volts, but it may be of importance when dealing with comparisons.

If we suppose a cell to be placed in a water bath, the temperature of which is 3·0° different from that of the cell previously, it may be concluded that after the lapse of half an hour the lag will not amount to more than 0·1 per cent. of the E.M.F., and will generally be less. In such cases the temperature coefficient should be diminished somewhat in value when correcting for actual variations, unless these take place with extreme slowness.

The cells were carefully examined, but, although small differences were apparent, their appearance furnished no characteristics by which the observed phenomena might be accounted for. The majority of the cells were constructed at the same time, and many were precisely alike as far as could be judged.

It has for some time past been suspected that the lag of the E.M.F. of a Clark cell behind the temperature was due not merely to the mean temperature of the cell itself lagging behind that of the bath but to time being necessary for the variation of the amount of crystals in solution and for diffusion to take place.

How far this cause of lag is diminished by the use of the H type of cell, where there is only one horizontal surface of contact between metal and liquid, we are about to determine experimentally.

There appears to be a general tendency for the E.M.F. of cells set up in accordance with the final specification issued by the Board of Trade to fall somewhat below the normal value after the lapse of some months. For example, the E.M.F. of cells set up in October, 1894, although, as a rule, not differing from 1·434 volts at 15° C. by more than 1 part in 3,000 when tested soon after construction, is now low by fully 1 part in 1,000. The same may be said of cells set up in November, 1894. But the E.M.F. of cells constructed in June, 1895, although falling, is still not low by more than about 1 part in 2,000.

THE ECONOMY OF THE MODERN ENGINE ROOM.

The difference between a good and a bad steam boiler is often that in the poor boiler the heating surface, while ample in area, is not properly utilised. In a good boiler, heating surface, says Dr. Emery in his article on "Boiler Selection" in the *Engineering Magazine*, is efficient. For the best effects the furnace for a boiler should have some connection in its design with the nature of the fuel employed. For economy the products of combustion should be uniformly spread over the heating surface. In some sectional boilers this cannot be done without such means as cause obstructions due to the lodgment of ashes, so giving rise to the very fault they were designed to prevent. A tubular boiler should apparently be easy to design for uniform distribution of the hot gases, yet this is often neglected, and very slight misproportions defeat the desired object. Where the tubes are of very ample size and area, the draught will take the easiest route to the chimney and select certain tubes only, and this fault is to be avoided by increasing the resistance of the tubes by general reduction of their area, though sometimes it is secured by ferruling the ends of some of the tubes. The author gives the cross area of the tubes for an anthracite burning boiler as one-eighth the grate area when the combustion is from 12 to 16 lbs. per square foot. With bituminous coal a ratio 1 : 6 or 1 : 7 is permissible, while, in respect of heating surface, a ratio of 25 to 1 of grate area is considered correct in marine practice. Dr Emery's rate of combustion of 9 to 10 lbs. of coal per square foot of grate seems small to us for land boilers. It may be desirable under certain circumstances, but 18 lbs. is a better figure to describe English practice. For marine boilers he gives 12 to 16 lbs. with natural draught, and 20 to 30 lbs. with forced draught, while in locomotives the rate may be 150 lbs., as to which he had better have qualified the figure by saying that it was based on the amount put inside the fire door, neglecting the "spark" account.

The combustion rate has little effect on economy, so long as the fire thickness is proportioned to the draft. We cordially agree with this, and have always urged a proper ratio of fire depth to draught, a ratio that is largely interdependent with the size of fuel used. In this latter regard, we think the American practice of grading anthracite coal to given sizes might be followed with advantage. Mechanical methods of stoking can always be followed to better advantage with graded and assorted fuel. With fierce draught a fireman cannot attend to a grate and keep it covered properly, and the fire needs to be so thick as to fall by gravity into the holes burned through it. Hence the success of the locomotive boiler on the road, for it is in a constant tremor, and the fuel is continually shaken into the hollows, while the frequent failure of the same boiler at rest is due to thinner firing and a still foundation. In all boilers the efficiency of the actual fire-box is so great, as compared with the efficiency of the heating surface generally, that no very serious difference is found between boilers having heating surface ratio to grate of 10 to 1 and boilers of 20, 40, or even 60 to 1 ratios. Thus the furnace in a boiler having a ratio of grate only a twelfth of the whole surface, evaporates fully half the water, and the remaining eleven-twelfths of surface evaporate the other short half.

The economy due to increased heating surface is a rapidly decreasing quantity. Thus with the ratio just quoted, if the furnace evaporates 5 units, and the heating surface evaporates another 4 units, of which one half at least would be evaporated by the unit area close to the furnace; successive additions of the same unit heating surface would only add to the evaporation, 1 unit; $\frac{1}{2}$; $\frac{1}{3}$; $\frac{1}{16}$; $\frac{1}{32}$; the unit heating surface being the furnace area, so that a surface eight to twelve times the furnace area would be needed to change the 5 units of furnace evaporation to a total of eight units.

Seeing that a boiler has to be designed for a given combustion and draught, and the passages are contracted so as to ensure efficiency of heating surface, it follows that slow steaming boilers are necessary to secure economy and steadiness.

For variable power a "free" boiler is needed, one that will burn coal quickly with a good draught and furnish a lot of steam quickly even at a sacrifice of economy, though this sacrifice need not be great as seen from the foregoing figures. Hence arises the boiler with large and short tubes of less rigid economy than the small but long tube boiler. Such boilers give satisfaction because they can be forced.

The author is strongly averse to the use of shell boilers in all office buildings. He calls for headroom sufficient to put in sectional boilers. We cannot agree with him here. No boiler ought to be placed where there is any dampness of foundation, and on a dry bed the shell boiler is as safe as any other, indeed, it has been lately shown to be a good deal safer than any other form. Neither for land or marine purposes has the sectional boiler shown itself free from defects which, taken in their frequency, mass up to far more disastrous results than have ever occurred or are likely to occur with equally modern shell boilers.

The danger of a boiler of any sort, even of the shell type, is not one of bursting pure and simple. Nowadays the dangers are chiefly a question of fittings and of small escapes of steam. We once knew of a case where a steam pipe broke and filled the room above with steam. Some men in the room only saved their lives by putting their heads out of a window. Some birds in the room died, not by any means of scalding but simply of suffocation, the steam having simply displaced the air and filled the space with vapour by no means very hot. The men were uninjured. Such an accident shows how life may be lost by a very small accident, and to these small mishaps sectional boilers are peculiarly prone.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1896.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

25,079. "Improvements in and in connection with conduits and collectors for electric tramways and the like." C. H. Gadsby. Dated November 9th.

25,121. "Improvements in locking gear for electrical switches." L. F. Awde. Dated November 9th.

25,123. "Improvements in incandescent electric lamps." W. Aubert, jun. Dated November 9th.

25,126. "Improvements in arc lamps." A. Pflüger. Dated November 9th.

25,143. "Improvements in or relating to electric arc lamps." R. J. Crowley and E. B. Payne. Dated November 10th.

25,170. "Loud-speaking long-distance telephone." Paul de Kilduchevsky. Dated November 10th.

25,214. "Improvements in electric light arc lamps." A. Casey. Dated November 10th.

25,242. "Improvements in electrical discharge apparatus." R. Belfield (A. J. Wurts and C. B. Skinner, United States.) Dated November 10th.

25,251. "Improvements in or connected with incandescent electric lamp fittings." A. Vandam and F. Harrison. Dated November 10th.

25,290. "An electric meter." J. F. De Bauw. Dated November 11th. (*Complete.*)

25,293. "Improvements in combined motors and electric generators." J. Atkinson. Dated November 11th.

25,323. "Improvements in electric motor regulators." W. A. Anthony. Dated November 11th.

25,343. "An improvement in electric locks for railway point and signal levers." E. Tyer. Dated November 11th.

25,345. "Improvements in communicating electrical energy to vehicles and apparatus for that purpose." Siemens Bros. & Co., Ltd. and A. M. Taylor. Dated November 11th.

25,346. "An automatic brake for an electric motor." Siemens Bros. & Co., Ltd., G. S. Grimston. Dated November 11th.

25,365. "An improved electrode for secondary batteries." H. Woodward. Dated November 11th.

25,370. "Improvements in electric incandescent lamps or their connections or holders." F. R. Pope. Dated November 11th.

25,481. "Improvements in electric pendants." H. Kray. Dated November 12th.

25,482. "Improvements in or relating to induction coils." S. Seubert. Dated November 12th.

25,500. "Improvements in or connected with electric lampholders, sockets, and the like." J. B. Verity. Dated November 13th.

25,506. "An electric alarum for inserting in locks." J. Harris. Dated November 13th.

25,541. "Improved vibration brake spring for gas, electric, or other lighting." G. May. Dated November 13th.

25,577. "Improvements in electrical transmitters and indicators for indicating and recording motion." R. M. Lowne. Dated November 13th.

25,600. "Improvements in or relating to electric arc lamps or lighting apparatus." J. Smith. Dated November 13th.

25,601. "Improvements in the cells or boxes of electric batteries." J. M. Moffat. Dated November 13th.

25,631. "Improvements in the means employed in the electrolytic production of the chlorates of sodium and potassium. T. Parker. Dated November 14th.

25,644. "Improvements in type-printing telegraphic apparatus." F. H. W. Higgins. Dated November 14th.

25,652. "Improvements in gramme ring armatures." R. Holiday and J. Freeman. Dated November 14th.

25,701. "Improvements in or connected with secondary battteries." J. H. May and F. King. Dated November 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps).*]

1895.

11,700. "Improvements in alternating current machines." W. C. Johnson and L. J. Steele. Dated June 15th, 1895. Relates to armatures for alternators, which are built up of a number of separate sectors, and are made with the inner surface of the combined sectors polygonal instead of circular, so that the air gap between the armature and the field-magnet poles is greater at the joints than at the middle points of the sectors. 1 claim.

11,708. "Improvements in electrically and directly controlled switches for electricity." R. Pippette. Dated June 17th, 1895. Relates to improvements upon the apparatus, &c., described in Specifications No. 16,768 of 1892, and No. 11,294 of 1893. The object is to enable any one of a given number of points to be electrically connected to any other point by means of switches electrically controlled from each point respectively, without (in some cases with) the intervention of an operator at the exchange. The invention is applicable to telegraphic, telephonic, lighting, and other purposes. In the exchange the wire or wires from each point pass to a switching apparatus, which includes a carrier passing over the switchboard, and which is controlled from the point, so that any person can put his wire in connection with any other point. The jacks are fitted with special contacts for testing, &c. The instruments may be reset by sending a current from the point, or switches may be arranged to automatically reset the instruments when the conversation (or passage of current) ceases. Numerous modifications of switching mechanism, including combinations of time switches, polarised electro-magnets, &c., are described for obtaining the proper connections at the exchange on a suitable system of signals or currents being sent from any point. 14 claims.

11,801. "Improvements in and relating to reflectors for electric incandescent lamps." C. Darrah. Dated June 18th, 1895. Relates to lamp reflectors for electric incandescent lamps, which are adapted for advertising or for ornamental purposes by cutting or otherwise forming letters, characters, or devices, in such a manner that they are plainly visible when the lamp is alight. The perforations in the reflector may be covered by glass, talc, or similar material. 1 claim.

12,187. "Improvements in telephonic apparatus." H. C. L. Holden. Dated June 24th, 1895. Telephones are mounted in relation to the call apparatus so that both are in series and either one or the other is short circuited by the switch, both are arranged in parallel between the line and earth or return or in one form of this arrangement a condenser is arranged in series with the telephone and is shunted when the receiver is taken off the hook. 1 claim.

12,546. "Improvements in electricity meters." Chamberlain and Hookham, Ltd., and S. H. Holden. Dated June 28th, 1895. Relates to quantity or energy meters of the motor type. In order that larger starting forces may be applied to the meter without danger of starting the meter prematurely, a larger and more constant stopping force is provided by means of one or more small pieces of iron attached to the armature disc or other part of the meter, which is attracted and held in position by the brake magnet when the meter stops. 1 claim.

19,866. "Improvements relating to inductance coils." R. Belfield. (A communication from O. B. Shallenberger, U.S.A.) Dated October 22nd, 1895. The object of the invention is to construct a coil in such a manner that the magnetic field due to the current circulating in the coil shall have a desired phase relationship (90° for example) with the E.M.F. producing the current. Means are also provided for maintaining this difference of phase notwithstanding variations in temperature. To attain the required phase difference, an auxiliary coil is provided so disposed with regard to the main coil that the current flowing in the main coil induces a current in the auxiliary coil, consequently the whole magnetic field is equal to the sum of the magnetic fields of both coils. By properly proportioning the auxiliary coil this magnetic field can be caused to assume any desired phase relationship with the impressed E.M.F. For maintaining the phase relationship constant under variable temperatures, an inductive resistance is placed in circuit with the main coil, and the magnetic circuit of this inductive resistance is automatically altered when the temperatures alter, so that when the temperature rises, self-induction of the inductive resistance varies as desired, for the resistance of the auxiliary coil may be made to vary with the temperature. The invention is principally applicable to the well-known alternating current meters of the Shallenberger type. 8 claims.

20,926. "Improvements in block systems for electric railways." R. Belfield. Dated November 5th, 1895. Relates to block systems for railways in which the track is divided into sections, each section having separate supply wires for supplying current to the car or a train on the section, and has for its object to provide means so that when the car or train is on the section, the supply of current to the train on the section next, or next but one, in rear of the first-named section is automatically interrupted. This is accomplished by causing the train to complete an electric circuit which acts an electro-magnetic switch located in the feeder wire of the section in rear or next but one in rear, and so interrupts the circuit through the feed wire. A considerable number of modifications are described in detail, the general idea of which is to render the working of these railways more safe and to prevent the risk of collision. 10 claims.